National Library of Canada
Canadian Theses Service
Ottawa, Canada
K1A 0N4

Bibliothèque nationale du Canada
Service des thèses canadiennes

NOTICE

The quality of this microform is heavily dependent upon the quality of the original thesis submitted for microfilming. Every effort has been made to ensure the highest quality of reproduction possible.

If pages are missing, contact the university which granted the degree.

Some pages may have indistinct print especially if the original pages were typed with a poor typewriter ribbon or if the university sent us an inferior photocopy.

Reproduction in full or in part of this microform is governed by the Canadian Copyright Act, R.S.C. 1970, c. C-30, and subsequent amendments.

AVIS

La qualité de cette microforme dépend grandement de la qualité de la thèse soumise au microfilmage. Nous avons tout fait pour assurer une qualité supérieure de reproduction.

S'il manque des pages, veuillez communiquer avec l'université qui a conféré le grade.

La qualité d'impression de certaines pages peut laisser à désirer, surtout si les pages originales ont été dactylographiées à l'aide d'un ruban usé ou si l'université nous a fait parvenir une photocopie de qualité inférieure.

La reproduction, même partielle, de cette microforme est soumise à la Loi canadienne sur le droit d'auteur, SRC 1970, c. C-30, et ses amendements subséquents.

NL-339 (r. 88/04) c

Canada

THE UNIVERSITY OF ALBERTA

LANGUAGE PROCESSING ABILITIES OF READING DISABLED, LOW ACHIEVING, AND NORMAL READERS

BY

JANICE LOUISE (CUDDY) TOMLINSON

A THESIS
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE
OF DOCTOR OF PHILOSOPHY
IN
SPECIAL EDUCATION

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA
SPRING, 1989

Permission has been granted to the National Library of Canada to microfilm this thesis and to lend or sell copies of the film.

The author (copyright owner) has reserved other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without his/her written permission.

L'autorisation a été accordée à la Bibliothèque nationale du Canada de microfilmer cette thèse et de prêter ou de vendre des exemplaires du film.

L'auteur (titulaire du droit d'auteur) se réserve les autres droits de publication; ni la thèse ni de longs extraits de celle-ci ne doivent être imprimés ou autrement reproduits sans son autorisation écrite.

ISBN 0-315-52957-1

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR Janice Louise (Cuddy) Tomlinson

TITLE OF THESIS LANGUAGE PROCESSING ABILITIES OF READING DISABLED, LOW ACHIEVING, AND NORMAL READERS

DEGREE FOR WHICH THESIS WAS PRESENTED Doctor of Philosophy

YEAR THIS DEGREE GRANTED 1989

Permission is hereby granted to THE UNIVERSITY OF ALBERTA LIBRARY to reproduce single copies of this thesis and to lend or sell such copies for private, scholarly or scientific research purposes only.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

(SIGNED) Janice L. Tomlinson

PERMANENT ADDRESS:

Provincial Education Assessment Centre,
G.F.Strong Rehabilitation Centre,
Vancouver, British Columbia V5Z 2G9

DATED January 3, 1989

SEP 26 1988

11311 Bird Rd.
Richmond, B.C V6X 1N7
Canada

Sept. 1988

Ms. Patrice Jones
Permission Dept.
Grune & Stratton,
Orlando, Fla. 32887

Dear Ms. Jones,

I am a doctoral student in Educational Psychology at the University of Alberta, Edmonton, Alberta. I have made reference to E. Carrow-Woolfolk and Lynch's book, An Integrative Approach to Language Disorders in Children (1982) in my thesis. I would like to use Figure 14-2, on page 322 of that book in my thesis, with your permission.

Time is of the essence, however, as my thesis must be in the library, with all permission forms attached, by October 12.

I would appreciate your assistance in this regard. My intention is to reproduce Figure 4-2 once in my thesis. Thank you very much.

Sincerely,

Janice Tomlinson

Janice Tomlinson

PLEASE TURN OVER

PERMISSION GRANTED
provided that:

you obtain the permission of the author(s);
the material to be used has appeared in our
publication without credit or
acknowledgment to another source; proper
credit is given to our publication(s)

Date 9/29/88 By Patricia M Jones
Permissions
The Psychological Corporation
Orlando, Florida 32887

Please note that the Grune & Stratton title for
which permission is requested has been assigned
to The Psychological Corporation.

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled LANGUAGE PROCESSING ABILITIES OF READING DISABLED, LOW ACHIEVING, AND NORMAL READERS submitted by Janice Louise (Cuddy) Tomlinson in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Special Education.

RMulcahy
Supervisor

L. Wilgosh

J. Watkinson

L. Stewart

Jim Cummins
External Examiner

Date November 18, 1988

ABSTRACT

The present study examined the relationship between syntagmatic and paradigmatic language processing and reading achievement in grade four students. The purpose of the study was to answer two questions. The first of these dealt with the types of word association paradigms used to measure syntagmatic and paradigmatic language processing, and the second examined the differential ability of different reading ability groups on these paradigms.

A multiple regression procedure was used to select the reading ability groups from a population of grade four students. The subjects selected represented low achieving, reading disabled and normal readers.

A set of eight tasks, representing different word association paradigms, were administered to all participating subjects. The results were analyzed by factor analysis, univariate and multivariate analysis of variance techniques to examine the differences between the paradigms, and the performance and processing differences of the three groups.

The results of this study demonstrated that the paradigms studied elicited qualitatively different measures of syntagmatic and paradigmatic language processing. The three reading groups did not differ in performance on the language tasks. However, the groups did exhibit processing differences, particularly on the paradigmatic language processing tasks. The paradigm differences were attributed to different information processing demands of the paradigms. The group differences were attributed to the interactions between the task demands and the types of information processing chosen by each of the three groups.

The major implications of this study are that future research should explore language processing within an information-processing model, and should

use word association paradigms as differential measures of language processing. In addition, future research should, within the information-processing model, explore the differential language processing abilities of reading disabled children in subtype investigation.

ACKNOWLEDGEMENTS

This thesis could not have been completed without the support and assistance of a number of important people in my life. I wish to thank Dr. Robert Mulcahy for his generosity in sharing his time and expertise with me. The dedication and energy with which he approaches his work has provided me a role model to follow throughout the ensuing years in my career.

Dr. Ronald Jarman has been a constant source of advice and encouragement throughout the course of this thesis. He painstakingly read and commented extensively on every copy of this document, providing me with endless hours of assistance.

Drs. Lorraine Wilgosh, Jane Watkinson, and Len Stewin were instrumental in the formulation of this document. Their insights and advice, particularly during the candidacy and oral defence examinations, were appreciated. Thanks are also extended to Dr. Grace Malicky, who was on sabbatical during the completion phase of this thesis, but whose advice during the earlier phases was beneficial.

It was my pleasure to be provided with the opportunity of meeting Dr. James Cummins, who served as the external examiner. Appreciation is extended to him for his thoughtful reading of the thesis, and for his insightful questions during the defence.

I feel honored to have been able to participate in two universities, and to have had the support and encouragement of many knowledgeable researchers at the University of Alberta and the University of British Columbia. This research was supported by the Social Sciences and Humanities Research Council of Canada, and by graduate research fellowships from the University of Alberta.

There are some other very important people in my life, whose support,

love and constant encouragement sustained me during the various phases of the doctoral program. To my best friend and my husband, Chuck, I want to express my love and my gratitude for making this dream come true. There are few people who would accept the challenge of parenting four children while their spouse goes to another city to study. I thank you for your patience, your understanding, your physical and emotional support, and your guidance throughout this whole process. Without you, it would not have been possible.

I have learned a great deal during the doctoral program. Perhaps some of the most important things I have learned have come from my children.

To my son, Chuck, I thank you for showing me the perseverance necessary to be a student again. I also wish to thank you for your word processing and bibliographic searching skills, which aided in the production of this document. Most importantly, I thank you for being a vital part of our family team, particularly during my absences.

To Kami, whose hard-working persistence over almost insurmountable challenges never ceases to amaze me, I thank you for teaching me that no challenge is too big to be tackled and achieved.

To Jessica, with your quiet patience, I thank you for the moments when you lent me your calming spirit and let your inner peace shine through to me.

To Ashleigh, whose life began with this project, I thank you for your energy and your exuberance, and for helping me to keep the many different parts of my life in perspective and in priority.

To my parents, Gordon and Marie Cuddy, who instilled a love of learning and the belief that all things are possible through faith and endurance, I give my thanks and my love.

Thank you, and God bless you all.

TABLE OF CONTENTS

ABSTRACT iv

ACKNOWLEDGEMENTS vi

LIST OF TABLES x

LIST OF FIGURES xii

Chapter I. INTRODUCTION 1

Chapter II. REVIEW OF THE LITERATURE 9
- A. LEARNING DISABILITIES 9
- B. READING DISABILITIES 11
  - 1. LANGUAGE SKILLS AND READING DISABILITIES 12
  - 2. RESEARCH ON READING DISABILITY SUBTYPE 16
- C. VERBAL PROCESSES 17
  - 1. ACQUISITION 17
  - 2. HISTORY OF WORD ASSOCIATION RESEARCH ... 22
  - 3. DEVELOPMENTAL LANGUAGE RESEARCH 23
- D. APHASIA RESEARCH 27
- E. COGNITIVE PROCESSING RESEARCH 29
- F. SUBJECT IDENTIFICATION 32
- G. TASK SELECTION 34
- H. SUMMARY 36

Chapter III. STATEMENT OF THE PROBLEM 41

Chapter IV. METHOD 43
- A. SUBJECTS 43
  - 1. SUBJECT CLASSIFICATION (PHASE ONE) 43
  - 2. IDENTIFIED SUBJECT GROUPS (PHASE TWO) 44
- B. TASKS 46
  - 1. SUBJECT SELECTION TASKS 46
  - 2. LANGUAGE PROCESSING TASKS 46
- C. PROCEDURE 50

Chapter V. RESULTS 52
- A. SUBJECT IDENTIFICATION DATA 52
- B. FACTOR ANALYSIS 60
  - 1. CORRELATION MATRICES 63
  - 2. PRINCIPAL COMPONENT ANALYSIS 67
  - 3. FACTOR SCORES 74
  - 4. ANALYSIS OF VARIANCE 74
- C. POST-HOC ANALYSES 82

Chapter VI. DISCUSSION 97
- A. WORD ASSOCIATION PARADIGM DIFFERENTIATION ... 98

B. READING DISABILITY SUBJECT GROUP DIFFERENTIATION 105
C. LIMITATIONS OF THE STUDY 117
    1. Restriction of Range 117
    2. Scales 117
D. SUGGESTIONS FOR FUTURE RESEARCH 118

REFERENCES 120

APPENDIX A: LANGUAGE PROCESSING TASKS 141

APPENDIX B: SCORING CRITERIA FOR SYNTAGMATIC AND PARADIGMATIC RESPONSES 146

APPENDIX C: TASK INSTRUCTIONS 149

LIST OF TABLES

Table 1: Sample Descriptive Statistics for Independent Variables Pooled for Group and Gender 52

Table 2: Subject Group Descriptive Statistics for Independent Variables 53

Table 3: t-tests for Gender on Independent Variables Within Subject Groups 54

Table 4: Sample Descriptive Statistics for Dependent Variables Pooled for Group and Gender 55

Table 5: Subject Group Descriptive Statistics for Dependent Variables 56

Table 6: Pearson Correlation Coefficients of Dependent Variable Raw Data for Reading Disabled Group (n=40) 57

Table 7: Pearson Correlation Coefficients of Dependent Variable Raw Data for Low Achieving Group (n=47) 57

Table 8: Pearson Correlation Coefficients of Dependent Variable Raw Data for Control Group (n=47) 58

Table 9: Pearson Correlation Coefficients Between Independent and Dependent Variables (n=134) 58

Table 10: t-tests for Gender on Dependent Variables Within Subject Groups 62

Table 11: Pearson Correlation Coefficients of the Dependent Variables for Reading Disabled Group, With Mean Gender Differences Removed 64

Table 12: Pearson Correlation Coefficients of the Dependent Variables for Low Achieving Group, With Mean Gender Differences Removed 64

Table 13: Pearson Correlation Coefficients of the Dependent Variables for Control Group, With Mean Gender Differences Removed 65

Table 14: Pearson Correlation Coefficients of the Dependent Variables for Total Subject Group, Corrected for Gender and Pooled for Gender and Group (n=134) 66

Table 15: Principal Components Analysis With Varimax Rotation for Pooled Group, Corrected for Gender 69

Table 16: Factor Score Means of Subject Groups 75

Table 17: Principal Components Analysis With Varimax Rotation for Subject Groups 84

Table 18: Procrustes Transformation and Error Matrices for Low Achieving Group on Control Group, Corrected for Gender 85

Table 19: Procrustes Transformation and Error Matrices for Reading Disabled Group on Low Achieving Group, Corrected for Gender 85

Table 20: Procrustes Transformation and Error Matrices for Reading Disabled Group on Control Group, Corrected for Gender 86

Table 21: Congruence of Pooled Matrix with Separate Subject Group Matrices . 91

Table 22: Comparison of ANOVA Differences and Procrustes Differences 93

Table 23: Task Discrepancies (From Table 20) in Descending Order of Magnitude 95

LIST OF FIGURES

Figure 1: The Integrative Model of Language, Showing the Dimension of the Communication Environment 21

Figure 2: Analysis of Variance Differences Between Groups on Factors 76

Figure 3: Graph of Procrustes Error Matrix for Reading Disabled Group on Low Achieving Group (corrected for gender) 88

Figure 4: Graph of Procrustes Error Matrix for Reading Disabled Group on Control Group (corrected for gender) 89

Figure 5: Graph of Procrustes Error Matrix for Low Achieving Group on Control Group (corrected for gender) 90

CHAPTER I. INTRODUCTION

Reading disabilities have been of concern to those in the fields of learning, teaching and parenting for many years. Theorists from various disciplines have struggled to increase clarity and understanding of the problems faced by reading disabled students. While the amount of information has increased dramatically, the achievement of clarity has been less successful. However, one area of consensus has been reached in the process. Language is essential to reading.

Early theories about a simplistic relationship between language and reading, however, have been discarded (Menyuk, 1983). Reading has been shown to be a complex skill which depends on many components of linguistic knowledge in response to a graphic diplay (Snyder, 1980). Studies of reading processes have emphasized the linguistic competence necessary for successful reading to occur (Gleitman and Gleitman, 1979; Goodman, 1969; Levin and Kaplan, 1971; Mattingly, 1972). When successful reading does not occur, as in children with reading disabilities, the language-reading relationship warrants further investigation.

The reading disabilities literature provides strong support for a language-based theory of reading disabilities. Although they are not pervasive to every child with a reading and learning disability, significant impairments in language processes have been identified within the population of reading and learning disabled children. Perhaps the most convincing evidence to date may be found in the reading disability subtype literature, which examines reading disabilities from many different foci in order to isolate individual kinds of reading disabilities with individual symptomotology (Boder, 1971; Denckla, 1977; Fisk and Rourke, 1979; Mattis *et al.*, 1975; Satz and Morris, 1981). Despite the variance in the methodology used and processes studied, some deficiency in language was found to be present within all subject groups. Learning disabled students appear to have deficiencies in language that are not characteristic of normal development.

Developmental language models have been structured primarily from a normal acquisition model (e.g., Bloom and Lahey, 1978). In normal development, language grows and changes over time, as cognition develops. One of the most significant changes studied by language researchers is the change from "unanalyzed, iconic, situation-bound to more abstract, symbolic and categorical utterances at the phonological, morphonemic, lexical and syntactic-semantic levels of linguistic functioning" (Doehring *et al.*, 1981, p. 109). Syntagmatic processing in normal language development is seen as a more immature form of conceptual development, often expressed through situation-bound or grammatical language responses. Changes in the lexical and syntactic-semantic levels indicate an ability to respond to words as abstract linguistic units and to process the meaning of whole sentences both grammatically and conceptually. At the lexical level in particular, children become able to process words paradigmatically, i.e. categorically and abstractly, rather than only syntagmatically, i.e. grammatically. In normal development, the advent of paradigmatic processing heralds a growth in cognitive development that is evidenced by language which indicates a deeper level of understanding of concepts. It has been proposed that the maturation of the temporal-parietal-occipital region of the left hemisphere, i.e. the association areas, may correspond to these syntagmatic-paradigmatic shifts (White, 1965), but further intensive investigation would be needed to fully address this issue.

An examination of the developmental language literature and the reading disability literature is not sufficient to explain the link between reading disabilities and language. Research in the two areas is driven by different theoretical constructs, and therefore cannot be directly compared. A theoretical basis common to both reading disabilities and language is needed to explain the relationship between the processes involved. Because of the nature of two such complex processes, an examination of the underlying subprocesses that affect both language and reading is necessary. The cognitive processing literature has suggested that simultaneous and successive cognitive processing may be related to both reading and language (Luria, 1966, 1973, 1982; Jarman, 1980; Kirby and Das, 1976).

The relationship between reading disabilities and language becomes somewhat clearer as one investigates the literature on dysfunctional language, or aphasia. Luria (1973) and Pribam (1971) have suggested that language dysfunction such as that seen in aphasia may be related to disruptions in cognitive processing. The dysfunctions identified may be related to the syntagmatic and paradigmatic processes discussed in the developmental literature. Paradigmatic aphasia, identified by syntactically correct but meaningless speech, is believed to result from a disruption in processing in the junction of the parietal, temporal and occipital lobes of the brain. The type of cognitive processing that occurs in this area is simultaneous processing, which is "distinguished by a type of nonlinear processing, such that elements of information may be compared to one another in composites or matrices" (Jarman, 1980, p. 157). Syntagmatic aphasia (Lashley, 1951, Luria, 1973), involving disruptions of the grammatical relationships between words, is associated with disruptions in the fronto-temporal area of the cortex. These areas are responsible for successive cognitive processing, or the "processing of information in temporal based sequential series"

(Jarman, 1980, p. 157).

The same cognitive processes that are felt to be related to syntagmatic and paradigmatic aphasia have also been shown to be related to reading disabilities (Cummins and Das, 1977; Kirby and Das, 1977). Although a simple dichotomy between simultaneous and successive processes does not propose to explain cognitive processes, and in particular, reading, both simultaneous and successive processing are believed to be necessary for successful reading to occur (Kirby and Das, 1977). Successive processing is thought to be strongly related to early reading achievement in skills such as decoding, and simultaneous processing is important for more advanced comprehension skills (Cummins and Das, 1977). Reading difficulties have been shown to be related to lower levels of these cognitive processes.

Hence, the linkage hypothesized between dysfunctional language and dysfunctional reading has been provided by underlying cognitive processing abilities. Both dysfunctional reading and dysfunctional language have been shown to be related to simultaneous and successive cognitive processing. The next step in the examination of the relationship between dysfunctional language and dysfunctional reading is to study, in reading disabled children, the same language processes that have been found to be deficient in aphasia patients. Syntagmatic and paradigmatic processes have been described by both the developmental and the aphasia literature. Because of their relationship to the same cognitive processes that are related to reading disabilities, it is reasonable to investigate whether there may be a connection between syntagmatic and paradigmatic processing and reading disabilities.

Since these processes have been examined in both the normal and abnormal populations, two ways of investigation are available to the researcher. The dysfunctional literature has used primarily a clinical interview approach in which language has been assessed for syntagmatic and paradigmatic deficiencies. Because of the extreme nature of the language deficiency involved, extreme samples of deficient processing are elicited. The developmental literature, on the other hand, has used paradigms such as word association tasks and variations to elicit syntagmatic or paradigmatic responses from their normal subjects. These tasks have been able to elicit developmental differences between subjects at various age levels. It is unlikely that clinical interviews using spontaneous speech as a measure would elicit language differences in a learning disabled subject group. However, tasks similar to those used in the developmental literature may be designed to elicit differences between normal readers and reading disabled students.

The developmental literature has used word association paradigms and other paradigms in their investigations, yet the differences between the types of tasks employed has not seemed to be an issue. The paradigms typically used in developmental research are free word association tasks, mediated word association tasks, sentence creation tasks, paired association tasks, closed choice alternative tasks, clustering tasks, and picture grouping tasks. Although some evidence of developmental differences has been shown relative to the type of task used, none of the research has used different tasks to explore similar processes with the same subject group. Comparisons such as this with reading disabled subjects would be able to demonstrate the sensitivity of selected language tasks and should provide a basis for comparison among selected tasks.

Reading problems are not specific to learning disabled students. The developmental language literature has yielded information about normally occurring language processes, and the aphasia literature has yielded information about dysfunctional language. If reading is dependent on language, then children who have reading problems, but who are not learning disabled, may also have language processing difficulties, although group differences would be expected. Such a subject group would be low achieving readers, students whose reading level is the same as for their learning disabled counterparts, but whose ability and achievement are not discrepant. These students are sometimes classified as slow learners in the classroom. While these subject groups have been discussed in other contexts, (e.g., Ysseldyke, 1982), their language processing abilities have not received attention in the literature. Knowledge gained about both of these subject groups will better clarify the true relationship between language and reading. A clear relationship between language and reading disabilities cannot be supposed in the absence of information about the language abilities of non-disabled subjects with equally poor reading, relative to their reading disabled peers.

The identification of these subjects groups, however, is a contentious issue. Many of the current methods of identification do not adequately discriminate between low achieving and learning disabled readers (e.g., Ysseldyke, 1982, 1985, 1986). One of the primary reasons for this is an inadequate understanding of the severe discrepancy which must exist between a child's ability and achievement in order for a true learning disability, as per current definition, to be present. Current research (Reynolds, 1984), however, has identified the regression model as the most appropriate one to use for identification of the subject group in question. The regression model can be used to identify potential achievement, which may be compared with actual achievement to identify students whose achievement is severely discrepant from their potential.

Although the language-reading relationship is well accepted, the relationship between language and reading disabilities is less clear. It is hypothesized that dysfunctional reading may be related to dysfunctional language. This relationship has begun to be illustrated through the developmental, aphasia and cognitive processing literature. Syntagmatic and paradigmatic language processes have been shown to be important developmental language processes. As indicated earlier, there are also two types of aphasia in the abnormal language literature, which have been labelled syntagmatic and paradigmatic aphasia, and have been shown be related to underlying cognitive processing deficits of simultaneous and successive processing. These same processes, simultaneous and successive, have been shown to be deficient in students with reading disabilities. What is not known is whether properly identified reading disabled students would also display abnormal syntagmatic and paradigmatic language processing patterns. This knowledge would further expand the information base about the language-reading disabilities relationship.

The purpose of the present study was to investigate language processes in reading disabled, low achieving and normal readers. Paradigmatic and syntagmatic language processing tasks were chosen for the investigation, since they appear to be theoretically linked to reading disabilities. The investigation was accomplished by administering paradigmatic and syntagmatic language processing tasks to grade four students. Subject groups of reading disabled, low achieving and normal readers were identified using a regression procedure and discrepancy formula. Analysis of the data investigated two major issues. The first issue addressed was that of paradigm diversity among the tasks. The second issue was the investigation of the differences between the subject groups on the language processing tasks. Denckla (1983) speaks of a "missing link" (p. 33) implicit in the relationship between spoken language and the acquisition of reading skills. The intention of this research was to provide information about the language of poor readers, both learning disabled and low achievers, in an effort to provide part of that missing link.

CHAPTER II. REVIEW OF THE LITERATURE

Language has been shown to be a major process affecting reading. This review of the literature will explore the research relating language and reading disabilities, with an aim toward better understanding of the relationship between the two processes.

A. LEARNING DISABILITIES

The literature on reading and learning disabilities has been extensive. As early as 1917, a condition called word blindness was identified in an intelligent male non-reader, and was attributed to a brain defect (Hinshelwood, 1917). In 1947, the concept of the brain-injured child was introduced by Strauss and Lehtinen (cited in Lerner, 1985), as one who may have perceptual, conceptual and/or behavioral disorders, as well as possible perseverative patterns, caused by neurological impairment before, during, or after birth. Early theorists verified difficulties in at least three separate and major information-processing areas: disorders of spoken language (Myklebust, 1954; Wepman, 1960; Kirk, 1961), disorders of written language (Gillingham, 1946; Spalding, 1957), and disorders of perceptual and motor processes (Kephart, 1955; Cruikshank, 1961; Frostig, 1964).

The term "learning disabilities" itself was not in use until 1963, when it was used by Kirk (1963) as a descriptive term to identify those children with seemingly normal intelligence and normal sensory abilities who were having difficulty learning under normal conditions.

Since 1963, the definition of learning disabilities has received considerable attention. It continues to receive constructive criticism from all groups concerned with those who have difficulty learning. The definition that is most widely used and accepted is a general one which was adopted for use in the Education for all Handicapped Act, Public Law 94-142 (U.S. Office of Education, August 23, 1977), in the United States, which reads:

> "Specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, which may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning problems which are primarily the result of visual, hearing, or motor handicaps, of mental retardation, or emotional disturbance, or of environmental, cultural or economic disadvantage. (Federal Register, Dec. 29, 1977, p. 65083).

The operational definition, included in the regulations concerning Public Law 94-142 (U.S. Department of Education, December 29, 1977) stressed that a severe discrepancy must exist between achievement and intellectual ability.

The definitions of the Canadian Association for Children with Learning Disabilities (1977) and the National Joint Committee on Learning Disabilities (Hammill, Leigh, McNutt and Larsen, 1981) stressed central nervous system involvement, and indicated that disabilities could occur at the same time as other handicapping conditions. The latter definition is as follows (Hammill *et al.*, 1981):

> Learning disabilities is a generic term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning or mathematical abilities. These disorders are intrinsic to the individual and presumed to be due to central nervous system dysfunction. Even though a learning disability may occur concomitantly with the handicapping conditions (e.g., sensory impairment, mental retardation, social and emotional disturbance) or environmental influence (e.g., cultural differences, insufficient/inappropriate instruction, psychogenic factors), it is not the direct result of those conditions or influences (p. 336).

Using such definitions, prevalance of learning disabilties has been investigated. The most appropriate estimates would appear to be those that result from empirical research. Studies which employ the same test battery and discrepancy formula employing two criteria for significant underachievement, i.e. achievement at less that 85% of potential in two areas, report a 4 to 5 per cent incidence of learning disabilities in school children. 7.5 per cent of children are identified when only one criteria for severe discrepancy is employed (Smith, 1983). Males outnumber females by at least a 2:1 ratio (Rubin and Barlow, 1971), which may be due to differences in neurological maturation (Townes *et al.*, 1980; Kinsbourne and Caplan, 1979; Denckla, 1979) or neurological organization (Hier, 1979; Kinsbourne and Caplan, 1979; Witelson, 1977), or other factors.

The learning disabilities field is vast, including many components. Current research into general information processing and use of strategy training with learning disabled children in general, and reading disabled children in particular has yielded some interesting and important results (e.g., Das, Snart and Mulcahy, 1982; Torgeson, 1975, 1980). The reader is referred to two excellent reviews by Stanovich (1986) and DeRuiter and Sansart (1982) for discussion of these components of learning disabilities, as they are not within the scope of this review. Rather, we will address a process that is pervasive to reading and reading disabilities, i.e. language.

B. READING DISABILITIES

Reading disabilites are a subset of learning disabilities. Definitions such as that developed by the Research Section on Developmental Dyslexia of the World Federation of Neurology have stressed the etiology of the disorder, and labelled it dyslexia: "Dyslexia is a disorder manifested in learning to read despite conventional instruction, adequate intelligence, and sociocultural opportunity; it is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin." (Critchley, 1970, p. 1). However, the significant issue in most definitions of both learning and reading disabilities is not etiology, but the discrepancy between abilitiy and achievement. Due to this discrepancy Frith (1981) has labelled reading disabilities simply but adequately as unexpected reading failure. Other definitions are more descriptive of the educational difficulties that children face, stating that reading disabilites are the failure of students, despite conventional instruction, to "attain the language skills of reading, writing, and spelling commensurate with their ability" (Critchley, 1970, p. 1). It is these language skills of reading, along with the underlying processes of language that are of concern in the reading disability question.

1. LANGUAGE SKILLS AND READING DISABILITIES

As early as 1937, Orton identified a lag in the acquisition and development of language skills in the reading disabled population. Since that time, language has been found to play a significant role in academic achievement (Cruickshank *et al.*, 1961; Myklebust, 1951). Myklebust (1974) wrote that the complexity of reading disabilities is

> ... apparent because of the evidence that many of these children also have with deficiencies of spoken language... Moreover, they are severely limited in use of the written word... In addition, and perhaps of considerable consequence, they are deficient in ability to integrate meanings, although interneurosensory processing was achieved. (p. 426)

Investigations with learning disabled subjects attest to these language and communication difficulties (Cruickshank, Bentzen, Ratzeburg and Tannhauser, 1961; Myklebust, 1954; Rosenthal, 1970; Vogel, Parker, Freston and Drew, 1975; Wiig and Semel, 1975a, 1975b, 1980).

Specific language processes have been studied in the learning disabled population. Phonemic coding has been explored in reading (Liberman and Shankweiler, 1980), and in reading disabilities (Snowling, 1981; Shankweiler *et al.*, 1979). The results support at least a specific phonetic coding deficit as part of a general language performance difficulty. Liberman *et al.* (1977) have studied phonetic segmentation and phonetic representation in short term memory and suggest that some poor readers are not sufficiently aware of the phonetic structure of spoken language. Awareness of articulation processes (Montgomery, 1981), auditory discrimination (Haggarty and Stamm, 1978; Hook, 1976; Wren, 1980; Wiig and Semel, 1976), and speed of auditory processing (Tallal and Stark, 1980; Tallal *et al.*, 1981) have also been shown to be deficient in the disabled student.

Vocabulary deficits have been postulated by Johnson and Myklebust (1967), who suggest that learning disabled children know fewer words, use restricted word meanings, and are more concrete and literal in symbolization and conceptualization skills than their normally achieving peers. Ellis and Miles (1981) suggest a general naming deficiency associated with dyslexia. Wiig *et al.* (1982) found that naming time and accuracy on rapid naming tests are significantly lower for learning disabled students compared with normal controls. Object naming and alphabet letter naming have been suggested as the two best predictors of reading readiness (Jansky and de Hirsch, 1973; Mattis, French and Rapin, 1975). Letter, object, picture and colour naming have been shown to be deficient in dyslexic children (Denckla and Rudel, 1974; Audley, 1976; Spring and Capps, 1974; Ellis, 1980). Investigations into the level at which the deficiency exists suggests that it is a lexical encoding, rather than an articulatory encoding problem (Ellis and Miles, 1981).

Vellutino and associates (1978, 1979) have suggested a verbal-deficit theory of reading disability, which includes inefficiency in the acquisition of linguistic rules and linguistic processing, as well as inefficiency in cognitive-semantic and logical processing. Vellutino maintains that perceptual difficulties that early readers may have are secondary manifestations of verbal mediation difficulties. These children have significant problems in the areas of oral reading and word analysis subskills (Vellutino, 1978). Fletcher (1980) and Snyder (1980) agree, suggesting that the beginning reader may be more dependent on graphic information and phonological decoding than older readers.

Linguistic knowledge, viewed as a process of syntactic and semantic processing, has been shown to be a significant factor in reading performance. This knowledge begins as language awareness in the young child (Downing, Ayers and Schaefer, 1981). As children grow older, the linguistic knowledge becomes more complex. Syntactical development allows more memory storage and more efficient processing and comprehension of the written word. Learning disabled students, however, may have difficulty at this level. Parker, Freston and Drew (1975) found, as in the memory processing research, that organization of written material did not facilitate recall in poor readers, in contrast to good readers. Wiig and Semel (1980) have found that vocabulary deficits, problems in interpreting verbs and adjectives, difficulties in use of pronouns and literal interpretations of metaphors and idioms are but a few of learning disabled students' language difficulties. A review of communication problems of learning disabled children (Bryan, 1978) revealed that children so defined had significantly greater difficulty in nonverbal communication, phonology, syntax, semantics, verbal mediation and language in social contexts.

Longitudinal studies of language-disabled children have also yielded important results regarding the connection between language proficiency and academic sucess. In a nine year follow-up study, Strominger and Bashir (1977) studied forty children, seen originally before the age of five because of delayed language and unintelligible speech. They report that no child was found without residual deficits. Of the 40 children studied, only two were on or above grade level on reading and written language tests. These two subjects, however, still had some mild sequencing, spelling and naming difficulties. Aram and Nation's (1980) longitudinal study yielded similar results, confirming that early language problems persist into school, and manifest themselves both in continued speech and language difficulties and below normal achievement in reading. Such difficulties are typically diagnosed as reading disabilities.

Blank (1978) and Doehring (1978) agree with a language basis of reading difficulties, but argue for more research in the area to more precisely define the nature of the language abilities of the reading disabled population. Strominger and Bashir (1977) caution against interpreting early language problems as the cause of reading and writing problems, and suggest that they are predictive symptoms of an underlying problem that changes with age. This underlying problem is, as yet, unexplained. The reading disability literature has attempted, in its search for an answer, to isolate subgroups of reading disabilities. This literature provides further support for a language-reading disability relationship.

2. RESEARCH ON READING DISABILITY SUBTYPE

Research into specific reading disabilities has yielded an interesting but confusing array of disability subtypes (Boder, 1971; Mattis *et al.*, 1975; Denckla, 1977; Satz and Morris, 1981; Fisk and Rourke, 1979; Lyon and Watson, 1981). This research has been structured on various theoretical frameworks to address both clinical (e.g., Boder, 1971) and neuropsychological (e.g., Fisk and Rourke, 1979) concerns. The aim of the research is to try to isolate homogenous subtypes of reading disabled students. The models and methodologies used in the search for subtypes, however, are varied and often do not relate to each other, so contentious results have appeared. Even so, the one clear fact that emerges from this body of literature is that language is a significant determining factor in the identification of reading disabilities. In each of the studies, at least one of the larger subtype groups is deficient in language. For example, Satz and Morris' (1981) cluster analysis revealed five subtypes of reading disabled students, three of which had a language base. Lyon (1982) identified three language deficient groups in five subtypes. Boder (1971, 1973) found deficiencies in word analysis skills in two groups, and Mattis *et al.* (1975) found two language deficient groups.

The reading disability subtype research has not addressed the language-reading disability question. Rather, in the search for homogenous subgroups of disabled readers, the language basis for reading disabilities has been supported. The actual intricicies of the relationship, however, are not clear from this body of literature, and need to be fully explored in research which specifically addresses itself toward a fuller understanding of how language affects reading. Indeed, although the reading disability research thus far has supported a relationship between language and reading disabilities, it has not described the intricacies of the relationship itself. Further investigation into normal language acquisition and processing may give insight into this relationship.

C. VERBAL PROCESSES

1. ACQUISITION

The discussion of reading as a language-based activity necessitates an examination of the development of the language system. Masland (1981) describes language as a highly integrated sensorimotor function, involving at least the association areas of the temporal lobe and the sensory and motor speech centers of the frontal lobe. The complexity of this system is realized in Chomsky's words, "Language is a mirror of mind in a deep and significant sense. It is a product of human intelligence, created anew in each individual by operations that lie far beyond the reach of will or consciousness." (Chomsky, 1975).

In response to growing knowledge of the complexity of language, the focus of language acquisition research has changed from a purely syntactic and semantic focus to a pragmatic focus (Golinkoff & Gordon, 1983). Pragmatic language is seen as functional, non-restrictive language (Bruner, 1983), and has been described by Bates & MacWinney (1983) as the tools used by speakers to carry out their intentions. The large sets of skills existing alongside pragmatics are language knowledge and language processing (Duchan, 1983). Language knowledge is comprised of phonology, morphology, syntax and semantics. Language processing is more open ended, and may include selective attention, speech perception,memory processes and perceptual strategies (Duchan, 1983).

The relationship between language and thought is complex and controversial, ranging from an equivalency position, in which language equals thought (e.g., Watson, in McGuigan, 1966) to a dependency position, in which either language is dependent on thought or cognition (e.g., Piaget, 1969), or thought is dependent on language (e.g., Luria, 1961), to an independency position, in which language and thought emerge as separate and independent functions and constantly interact on one another (e.g., Vygotsky, 1962). However, there is support to indicate that, once developed, language can extend thought and can allow experiences to be held within a verbal format (Carrow-Woolfolk and Lynch, 1982).

Language initially develops as seemingly unrelated and meaningless "prespeech" sounds made by an infant (Trevarthen, 1979). These sounds become increasingly differentiated and eventually turn into recognizable words. Thought can be seen to interact with language as one watches a young child respond to the language in his or her environment. This response is due, in part, to the amount and quality of receptive language that the child possesses. The development of this receptive language is determined by both sensory and cognitive ability, as well as by environmental factors such as opportunity for learning. Halliday (1975) refers to this stage as the stage of protolanguage, which usually occurs around ten months of age. At this age, the infant begins to respond to instructions, wishes and feelings of those around him, and to emit vocalizations that appear to have meaning. Over the next year, these vocalizations expand and specialize. Expressive language develops, and the child becomes able to transmit thoughts and ideas through language. For the next few years, oral language continues to develop at a remarkable rate.

Models of normal language development, such as Bloom and Lahey's (1978), typically have included the various components of language, such as semantics, phonology, syntax and pragmatics, and have stressed that language is the integration of these components, more simply labelled as content (semantics), form (phonology and syntax) and pragmatics (use). Some cognitive theorists (e.g., Stark, 1981) have suggested a hierarchical language learning model, in which the learning of smaller units, such as phonemes, is dependent on larger units, such as words and sentences, and is affected by cognitive processes, such as attention and memory. Others have stressed other cognitive skills, such as perception (Menyuk & Menn, 1979), decentration (Gerber & Bryen, 1981), interpretation and evaluation of the message, and feedback (Wiig & Semel, 1976).

The two major theories of information processing which have been related to language processing (Butler, 1984) have been the multi-store model (e.g., Atkinson and Shiffrin, 1968, 1971) and the levels-of-processing model (e.g., Craik and Lockhart, 1972). Butler (1984) has described the former as a "bottom-up" (p. 64), or data-driven model, in which the information moves from the sensory register, through short term and into long-term memory, as a result of the inherent stucture of the memory store, and the control processes (e.g. rehearsal) which the learner exhibits on it. The levels-of-processing model emphasizes the depth of processing that the learner imposes on the material to be learned. Shallow processing results in less retention than deeper processing, i.e., "memory improves because processing reaches greater semantic depths" (Butler, 1984, p. 69). This model also emphasizes the importance of the context in which the information is encoded, and the semantic knowledge which is already in the individual's long-term store, as being important components of both the encoding and the recall process. While both models have been used in language research, the levels-of-processing model has incorporated much of what is known about children's use of strategies for learning and remembering information (Butler, 1984). However, the incorporation of both of these models is possible, and preferable to choosing one model over the other, when illustrating the complexities of language processing.

Carrow-Woolfolk and Lynch (1982) have also provided a language model which integrates research on cognitive and psychological processing with linguistic research. Their model is four dimensional, representing 1) the linguistic code, including phonology, syntax, semantics and pragmatics; 2) cognitive processes, including memory, perception and conceptualization; 3) language performance, including speaking, reading and writing; and 4) the communication environment, including internal needs and external reinforcement. Figure 1 illustrates the multidimensional nature of language performance involving the integration of cognitive, linguistic and social domains. The development of cognition is "essential to the development of the linguitic code" (Carrow-Woolfolk and Lynch, 1982, p. 57). Both cognitive and linguistic knowledge are used in the production of language. The needs and desires for communication "form the central core of the communication process" (Carrow-Woolfolk and Lynch, 1982, p. 57). The model also illustrates how deficits in one domain may affect the development in other domains in varied and complex ways, suggesting further support for the language-reading disabilities relationship.

The interrelationship of language, cognition, memory and context is very evident in these language processing models. In order to fully investigate the relationship between language and reading disabilities, it is necessary to examine

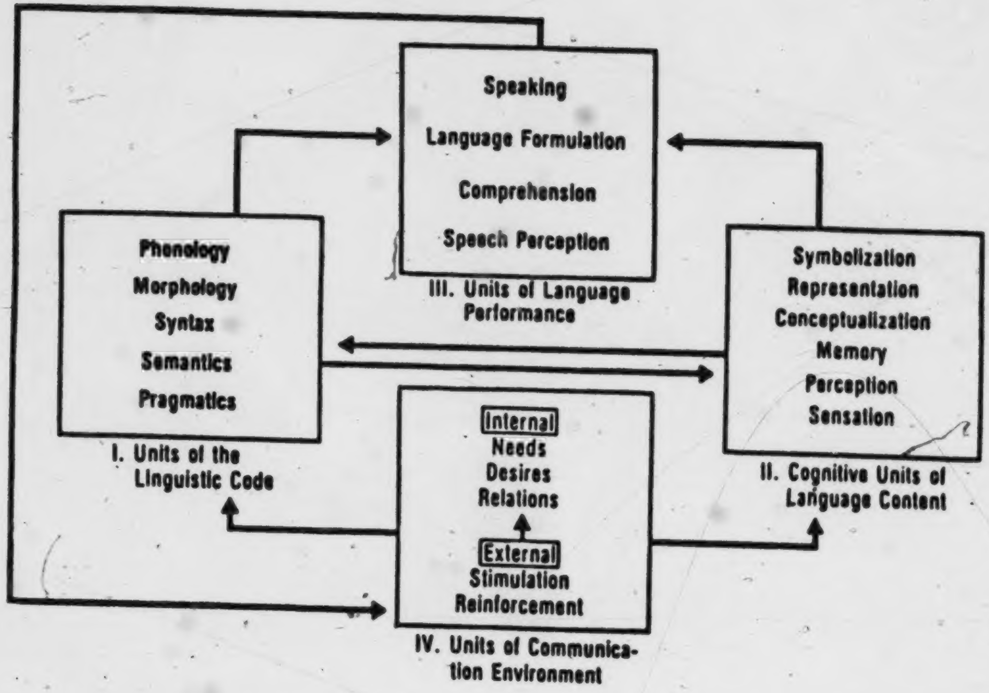
Speaking
Language Formulation
Comprehension
Speech Perception
III. Units of Language Performance
Phonology
Morphology
Syntax
Semantics
Pragmatics
I. Units of the Linguistic Code
Symbolization
Representation
Conceptualization
Memory
Perception
Sensation
II. Cognitive Units of Language Content
Internal
Needs
Desires
Relations
External
Stimulation
Reinforcement
IV. Units of Communication Environment

Figure 1: The Integrative Model of Language, Showing the Dimension of the Communication Environment

Note: From An integrated approach to language disorders in children (p. 322) by E. Carrow-Woolfolk and J. Lynch, 1982, New York: Grune & Stratton. Copyright 1982 by The Psychological Corporation. Reprinted by permission.

the very basic processes of language. Two of these processes have been defined by both the developmental language and the aphasia literature. These processes are syntagmatic and paradigmatic processes. They will be reviewed in the developmental literature first. Much of this literature is based on word association studies that investigate language occurring after the initial acquisition of language.

2. HISTORY OF WORD ASSOCIATION RESEARCH

The study of word association has existed for some time. In 1918, C.S. Jung reported his experimental results of word association studies, and stressed the relationship between these results and his theory of psychological complexes. Although this focus was interesting in the psychoanalytical arena, Jung's approach to the study of personality and thought processes, through word association tasks, gradually decreased. A few years earlier, Woodrow and Lowell (1916) and Rosanoff and Rosanoff (1913) had found that free associations of children were semantically different from those of adults. Children gave responses that indicated more contiguous and whole-part associations, while adults gave more contrast, co-ordinate and similarity responses. Interest in this area of word association also waned, however, and was not revived until the 1960's.

The revival was in a verbal learning context, as cognitive theorists began to study word association as a medium for exploring the areas of language and thought (Deese, 1965; Clark, 1970). One specific area of word association that was of particular interest was the difference between child and adult responses identified almost five decades earlier. The major principle by which the responses were differentiated was that of syntax. Children more often made associations that were different parts of speech than the stimulus word had been, while adult responses were most often the same part of speech (Ervin, 1957, 1961; Brown and Berko, 1960). Indeed, Woodrow and Lowell (1916) had hinted at this differentiation in several cases, speaking of adjective-noun and verb-object association made by some children. Brown and Berko (1960) labelled these classifications as "homogeneous" and "heterogeneous". Subsequently, Ervin (1961) named them syntagmatic and paradigmatic. Young children's associative responses were typically syntactical, with the associated word of a different form class than the stimulus. Adult paradigmatic responses were typically of the same form class as the stimulus. The change in associative responses was seen as a developmental shift as a consequence of the child's gradual organization of his vocabulary into syntactic classes, and was labelled the syntactic-paradigmatic shift (Entwisle *et al.*, 1964).

3. DEVELOPMENTAL LANGUAGE RESEARCH

Theories of word association have been associated with the syntagmatic-paradigmatic shift, as it is now known, in an effort to understand this phenomenon. The simplest and the oldest theory is that of contiguity, or associative strength (Ervin, 1961; McNeill, 1963; Palermo, 1971), in which words are believed to be associated together in one's mind primarily because they have been frequently experienced in the past. This process is aided by erroneous anticipation of sentential completion, and by an increasing variety of sentential contexts (Ervin, 1961). This theory, however, did not account for the numerous words which may be associated, but which do not occur together in the same sentence, such as fat and thin, or smooth and rough (McNeill, 1966).

There did appear, however, to be basis for a theory based on language structure and word features (McNeill, 1966; Chomsky, 1965; Katz and Fodor, 1963). It appeared that words had many features which were learned one by one by children, the most crucial one being learned first. When the child had acquired only a few of these features, word association responses would be syntagmatic, and would only change to paradigmatic as their understanding of the many other features of the word increased. Paradigmatic associations were not recalled, but were generated by rule in the association test (McNeill, 1966). This theory was supported by Lippman (1971), who studied students in kindergarten, grade two, grade four and college and found increasing ability with age to give nominal, relational, dimension and opposite reasons for why two nouns or adjectives were associated. Clark (1970) suggested a number of rules for generating word associations from linguistic structure, thus agreeing that associations were derived from language structure. While this is true for many associations, Nelson (1979) argued that it cannot account for the large amount of semantic knowledge that allows younger children to use familiar words appropriately in context.

Others saw memory as a probable link with semantics, and a theory proposing a psychological structure of semantic memory, which stressed the functional relationships between and among words, was suggested (Deese, 1965; Anderson and Beh, 1968; Anderson and Bower, 1973). This classification system was more conceptual than the grammatical systems previously proposed. Functional paradigmatic relationships were logical, i.e. the associated words had some meaning in common. Responses that did not fall into this logical category were called syntactic, and were usually observed in younger children (Stolz and Tiffany, 1972; Lippman, 1971; Francis, 1972). However, this system did not explain how younger children could sometimes make paradigmatic responses to noun stimuli. Francis (1972) suggested that, although form class could decribe associations that children made between words, the children may not be using form class as their response strategy. Rather, younger children gave associations in terms of interrelations among word meanings, while older children's responses were based on the comparison of semantic relations between words. Reid (1974) agreed that syntagmatic relations could be dependent on the functional relationships existing between the features of the words, while paradigmatic relations could be dependent on similar conceptual features.

Neither knowledge of form class, semantic or functional relations, however, has been deemed sufficient to explain the responses given in word association tasks. Both syntactic and semantic learning are necessary for the syntagmatic-paradigmatic shift to occur, but they both "rest on cognitive abilities" (Francis, 1972). Emerson and Gekoski (1976) suggested splitting paradigmatic responses into two categories - interactive and categorical. Interactive responses are those that result from putting the stimulus into an action sequence, regardless of form class. The phenomenon of nouns producing paradigmatic responses in young children could be explained by an interactive relationship. For example, an interactive noun response to the word train would be tracks; to the word horse would be saddle. Categorical responses are those that show an understanding of the functional relationship between the stimulus and the response word. Using the same example, a categorical response to the word train would be bus, to the word horse would be cow. In a study of children aged 3.0 to 9.11, virtually all of the young children's paradigmatic responses were interactive. Categorical responses were not well formed until 7 to 8 years, and even then, children chose to use both categorical and interactive strategies for responding.

Realizing the underlying cognitive basis of the syntagmatic paradigmatic shift, Moran (1966) proposed that there may be developmental stages reflected in the type of response given by the child. His suggestion that the stages were hierarchical, ranging from perceptual referent (predicative/syntactical) to object referent (functional) to conceptual referent (synonym-superordinate) to dimensional referent (co-ordinate-contrast), was not supported (Penk, 1971; Cramer, 1974).

Young children's early conceptual associations were presumed to be formed on the basis of possible functional relations and perceptual attributes related to the child's real world experiences (Nelson, 1974, 1977; Schank, 1976). Children also began to categorize objects into natural and common categories, such as animals, clothing, etc., in the preschool period (Harris, 1975; Nelson, 1974; Hall and Halperin, 1972; Steinberg & Anderson, 1975), even though they were not able to verbally explain the associations. Nelson (1977) proposed that children were able to make associations via relations, properties and functions at varying levels, dependent on the "salience of particular relationships for a particular word concept" (p. 112). With increasing age, verbal fluency and school experience, contrast and coordinate responding for noun and dimensional responding for adjectives would increase.

Although the developmental literature has explored syntagmatic and paradigmatic processes as significant to the language development of the child, it has been unable to explain these processes in a consistent manner (Nelson, 1977). Jarman (1980) has pointed out two major limitations of the developmental literature. Firstly, the movement from syntagmatic to paradigmatic responses has been seen as little more than a shift into another hierarchy of associations, and does not explain why competent adult speakers may use both types of processing. Secondly, although syntagmatic and paradigmatic processing have been accepted as evidence of conceptual and cognitive development, the literature has not addressed the issue of individual differences in development. It may be supposed that there are developmental differences between children of the same ages, which may be evidenced on word association tasks.

The reading disability literature has stressed the importance of language to the reading process, and has demonstrated the difficulties that reading disabled children have with some language tasks. If reading is dependent on language, dysfunctional reading may have a strong relationship with dysfunctional language. With this relationship in mind, the aphasia literature will be reviewed.

D. APHASIA RESEARCH

Syntagmatic and paradigmatic processing are significant in the aphasia literature. This literature on abnormal language has identified distinctive disturbances, labelled syntagmatic and paradigmatic aphasia (Geschwind, 1970; Jakobson, 1971; Luria, 1973; Weigl and Bierwisch, 1970). These disturbances are identified somewhat differently than by the word association approach that is used in the developmental literature. The emphasis is on the whole structure of an utterance, i.e. a sentence, rather than on single words.

Syntactic relationships were felt to emerge early in development, as soon as a word began to acquire an independent existence (Luria, 1982). The development of these "syntagmas" (p. 117) had the ability to change single word sentences, for example, "up", into two and three word sentences, such as "want milk", "daddy come" (Brown, 1973; Halliday, 1975). The paradigmatic and the syntagmatic principles (Jakobson, 1971) separated these structures primarily on a grammar versus meaning distinction. Syntagmatic utterances were employed for the communication of events, and were grammatically based (i.e. noun-verb). Rather than a hierarchical system, the syntagmatic system was seen as a serial system, in which the transition from one word to another was important. Indeed, the "expression of a thought in words is determined... by the principle of successive syntagmatic linkages" (Luria, 1982, p. 119), which were seen as more natural forms of speech than paradigmatic systems.

Paradigmatic utterances are used in the communication of relationships, and the meaning of the utterance is stressed. While the syntagmatic system has its basis in a sentential context, the unit of importance in the paradigmatic system is the word, and the emphasis is on the word's relationship with other words. This system has been seen as a hierarchical system, with the relationship of one element building on another. For example, dog is hierarchically related to domestic animals, which are hierarchically related to mammals. In addition, the opposition principle applies in the paradigmatic relationships. Words may be in direct opposition one to another, as black is in opposition to white, for example. These principles of opposition and organization within the hierarchical system are the basis for concept formation (Luria, 1982).

Disturbances in both syntagmatic and paradigmatic systems were often seen in aphasic patients (Geschwind, 1970; Jakobson, 1971; Luria, 1973; Weigl and Bierwisch, 1970), enabling aphasia to be classified into paradigmatic and syntagmatic aphasia. Paradigmatic aphasia was classified as a primary disruption in communication, based on the relationship and meaning between the parts of a sentence or phrase. Patients with this type of disturbance are often unable to understand logico-grammatical relationships, such as the difference between "the brother's father" and "the father's brother" (Luria, 1973, p. 40). Naming deficiencies and inability to understand adverbial phrases are also characteristic of this disorder. Syntagmatic disturbances are the disturbances in the actual grammatical constructs of a sentence or phrase, as well as predicative deficiencies, i.e. deficiencies in verb use. To understand the underlying process of syntagmatic and paradigmatic aphasia, it is necessary to look at research that has been able to strengthen the link between language and cognitive processing.

E. COGNITIVE PROCESSING RESEARCH

The disruptions which occur in syntagmatic and paradigmatic processing in aphasia have been related to underlying cognitive processes (Luria, 1973; Pribam, 1971). The structural basis of cognitive processing and language disturbances is grounded in Luria's (1966, 1970, 1973) model of the brain. He suggested that the brain is divided into three functional systems, which he labels blocks. The first block, responsible for arousal and maintenance of wakefulness, consists of the brain stem and reticular formation. The second block includes the parietal, occipital and fronto-temporal lobes, and is responsible for information input, processing and storage. Planning and decision-making take place in the third block, in the prefrontal and frontal areas.

Within the second block, Luria (1970, 1973) has identified two cognitive processes that are significant in processing information. The first of these, simultaneous processing, involves the integration of input information into a form which can be viewed in its entirety as one unit. The integration of the information involves the relationship of the pieces of information with one another. Spatially, simultaneous processing can be described as the categorization of information into a gestalt. Linguistically, the description would focus more on the interrelationship of meaning between the words. Simultaneous processing is often viewed as a spatial phenomenon (Cummins and Das, 1977), but it can also be observed linguistically.

The second type of processing identified, successive processing, is almost the direct opposite to simultaneous processing. In successive processing, only one piece of input information is available to the processor at one time, so the brain must store each individual piece of information. Recent research (Naglieri & Das, 1987) has indicated that the type of coding required by linguistic tasks is dependent more on the task demands than the content or modality of presentation.

Disruptions in these cognitive processes have been suggested to be the basis for paradigmatic and syntagmatic aphasia (Pribam, 1971; Luria, 1973, 1982). Syntagmatic aphasia is believed to be the result of damage to the fronto-temporal cortical area, the site of successive cognitive processing. Damage to the temporo-parieto-occipital areas of the left cortex, the site of simultaneous processing, is believed to result in paradigmatic aphasia.

This link between language and cognitive processing has been supported in the literature (Jarman, 1980; Cummins and Das, 1978; Cummins and Mulcahy, 1979). Simultaneous processing has been related to verbal reasoning performance (Cummins, 1973). High syntactical complexity in story recall has been related to successive processing. Speed of speech output, felt to be related to the understanding of the relationships between the story elements, was related to simultaneous processing (Cummins and Mulcahy, 1979). Word clustering tasks, used to measure paradigmatic and syntagmatic processes, have been linked to cognitive processing (Jarman, 1980). Syntagmatic clustering tasks were found to load on a successive factor, along with successive tasks. Paradigmatic clustering tasks loaded on a simultaneous factor, with other known simultaneous tasks. These results "are consistent with the premise that the cognitive processes underlying paradigmatic and syntagmatic clustering are simultaneous and successive syntheses respectively" (Jarman, 1980, p. 159).

These same cognitive processes have been found to be related to reading and reading difficulties. Successive processing has been related to reading disabilities (Doehring, 1968; Kinsbourne and Warrington, 1966) and studies on the acquisition of reading skills in the educable mentally retarded population (Blackman, Bilsky, Burger and Mae, 1976; Blackman and Burger, 1972). Kirby and Das (1977) have shown a relationship between reading and cognitive processing in normal readers. High reading achievement was related to high levels of both successive and simultaneous processing, while low reading achievement was related to low levels in both types of processing. Intermediate reading achievement was found in those students who were low in one mode and high in the other. It was concluded that both types of processing are necessary for high reading achievement.

Cummins and Das (1977) have investigated this relationship with students with reading difficulties, and concur that "competence in successive processing is strongly related to reading achievement (p. 250). Simultaneous coding may be more important at advanced stages of reading, but successive processing at an earlier level is necessary for the development of decoding skills. This information allows the language-reading disability connection to be supported theoretically.

Cognitive processes of simultaneous and successive processing are necessary for both language and reading processing.

To further investigate this relationship, research needs to compare the syntagmatic and paradigmatic language processes of reading disabled students with both low achieving and normal readers. Before that process can take place, however, issues regarding subject identification and task selection have to be investigated.

F. SUBJECT IDENTIFICATION

Identification of reading disabled students has been problematic for several reasons. The definition of learning disabilities itself, under which category reading disabilities are found, has had a different focus depending on the discipline which was formulating the definition. Medicine, psychology and education have all contributed not only to the understanding but also to the confusion surrounding learning disabilities. Definitions have consistently been definitions "by exclusion" (Satz, 1981) and single definitions have been operationalized at least forty different ways in the literature (Ysseldyke *et al.*, 1982). Nonetheless, consensus has been reached among the disciplines about a discrepancy between potential and achievement in learning disabilities.

The results of some of the research on reading and learning disabilities may have been confounded as a result of not measuring these discrepancy criteria, and therefore inadequately discriminating between learning disabled and low achieving children. Because characteristics of low achieving, learning disabled, mentally retarded and normal subjects have overlapped considerably (e.g., Ysseldyke *et al.*, 1982; Weener, 1981; Neisworth and Breere, 1975), discrimination between the groups is vital. The two groups that are most closely related in low reading ability levels are the learning disabled, more specifically reading disabled, and the low achieving groups. Research using reading disabled students as a subject group must carefully identify its subjects by discriminating between reading disabled and low achieving subjects using discrepancy criteria. Reading disabled students are those who display a severe discrepancy between expected and actual reading achievement; low achieving students are those whose low reading achievement matches expected reading achievment.

The methodology to be used in this discrimination has not always been clear. The measurement of actual reading achievement must clearly indicate what operational definition is being used for "reading", and must take comprehension into account as well as word analysis and knowledge.

The measurement of expected or predicted reading achievement is vital to the identification of reading disabled students. Simplistic formulae of comparing standard score IQ's with standard scores on reading achievement tests are conceptually unsound, failing to take into account the effect of regression of achievement scores towards the mean. Calculations of expected grade equivalency based on chronological and mental age have been judged mathematically inadequate (e.g., Berk, 1984).

Four criteria have been found to be necessary in any measurement of severe discrepancy (Reynolds, 1984). These criteria are a regression model, a reliable simple difference score between aptitude and achievement, the relative infrequency of the difference in the general population, and standard scores. Although discrepancy models have been used in the past (e.g., Horn and O'Donnell, 1984), they have not used these four criteria measures in calculating severe discrepancy. In addition, severe discrepancy has been viewed in the literature as both intra-individual and inter-individual, i.e. the reading achievement of an individual has been seen to be discrepant when compared with his/her own or others expected achievement. Research studies need to clearly state which form of the definition they are adopting.

Attempts have been made to use a regression-discrepancy model to discriminate between low achieving and learning disabled students. Horn and O'Donnell (1984) used multiple regression analysis to calculate students' expected reading achievement. By comparing expected and actual achievement, they obtained discrepancy criteria. Although somewhat faulty methodologically in its use of raw scores rather than standard scores, the analysis did discriminate between learning disabled and low achieving students. However, no attempt was made to study or compare the two groups on any criteria measures, as a follow-up to the discrimination process. Processes specific to the nature of learning disabilities need to be studied in both the learning disabled and low achieving populations to assess the differences in performance between these two groups. Language, the underlying basis of reading, needs to be studied in properly identified reading disabled and low achieving children.

G. TASK SELECTION

Task selection in the reading disabled field has varied in both scope and application. The reading disability subtype literature is the most current example of this methodological fault. By trying to address all the possible sub-components of reading disabilities, sometimes without a basis in theory, the results in the literature have been confounded and questionable. An in-depth study of one primary process underlying reading disabilities is needed. The literature indicates that that one primary process may be language.

While the language literature is theory-based, it is not without its methodological problems. The developmental and verbal learning literature has tended to view language processing, and in particular paradigmatic and syntagmatic language processing, in a unitary hierarchical fashion, without regard to individual cognitive differences. It is difficult to relate these processes to reading disabilities, which may be a function of individual cognitive differences. The aphasia literature does investigate these processes from a cognitive theory base, and yields important information to language research. However, it explores paradigmatic and syntagmatic processes through research which is more clinical than experimental. What is needed is experimental research based on a language theory of reading disabilities which will investigate the differences in paradigmatic and syntagmatic processing in reading disabled students, as compared with other groups of poor and normal readers. The theoretical model proposed by Luria (1966, 1970, 1982) would be an excellent basis from which to explore the relationship between language and reading disabilities because it explores one of the basic language processes.

The investigation of the relationship between language processing and reading disabilities must employ tasks which have been shown to produce paradigmatic and syntagmatic responses. Word association tasks have been shown to consistently elicit syntagmatic and paradigmatic responses in a way that differentiates between age groups. The various forms of word association tasks, as well as other paradigms reported in the literature, include free word association, closed choice alternative, paired association, associative recognition, picture grouping, sentence creation and clustering tasks. Although developmental differences have been shown to be related not only to the processes themselves, but also to the type of task used to elicit the responses, the tasks are treated as a unitary process in the literature. For instance, while associative recognition tasks can elicit paradigmatic responses by age seven, sentence completion tasks do not elicit such responses consistently at age eight or nine, The literature has not addressed the difference in complexity between the tasks used to study paradigmatic and syntagmatic responses. By attending to method variance, research will be better able to identify process variance (Jarman, 1980).

However, the type of task itself is not the only criterion that must be investigated in the discrimination between paradigmatic and syntagmatic processes. The stimuli used in the tasks are of extreme importance. Traditional word association studies have primarily used lexical words, i.e. nouns, adjectives and verbs, that elicit contrast and coordinate responses (Nelson, 1977). New lists of stimuli must be constructed to elicit coordinates, superordinates, functions and properties (Nelson, 1977), if research is to gain more understanding of the complexities of paradigmatic and syntagmatic processing.

H. SUMMARY

The process of learning to read, and reading itself, has been found to be dependent on language. Because language and reading often do not develop successfully, curiosity is piqued. One of the major problems in education is the prevalence of students who have difficulty learning to read successfully. In order to study this group of students, it is natural to look at a process directly related to reading. As shown by the review of the literature, that process is language.

Studies of language difficulties in reading disabled children have demonstrated deficiencies in vocabulary (Johnson and Myklebust, 1967), phonemic coding (Snowling, 1981), syntax and semantics (Bryan, 1978). Longitudinal studies have emphasized the relationship between language deficiencies and academic success. The reading disability subtype research, while investigating many areas of reading disabilties using various methodologies and tasks, has demonstrated that language plays a major role in reading disabilities (Boder, 1971; Fisk and Rourke, 1979; Satz and Morris, 1981).

Because the research supporting a language basis for reading disabilities is drawn from many different theoretical constructs, direct comparison of the results is difficult. The reading disabilities literature has supported the theory that reading disabled children may have difficulty with some language processes. A full understanding of the language of reading disabled children, however, involves an understanding of the language of normal, i.e. non-reading disabled, children. The developmental literature has emphasized the syntagmatic-paradigmatic shift as an important and significant stage in language, which signifies cognitive and conceptual growth (Moran, 1976; Nelson, 1974, 1976; Emerson and Gekoski, 1976). Considerable research has been carried out to investigate these processes, but to date no clear answer has emerged (Nelson, 1976). The investigations have used primarily word association tasks or variations of the word association paradigm to elicit syntagmatic and paradigmatic responses.

The developmental literature has emphasized significant language processes that are indicative of conceptual and cognitive growth. It has also developed a large number of tasks to use when studying syntagmatic and paradigmatic processing. However, this literature is grounded on entirely different theoretical constructs than the reading disability literature, so the relationship between language and reading disabilities does not appear to receive any further support from this literature. The fact that reading is dependent on language may suggest that dysfunctional reading may be based in dysfunctional language. The dysfunctional language literature, i.e. aphasia, begins to provide the theoretical basis needed to explain this relationship (Jarman, 1980).

Deficiencies in syntagmatic and paradigmatic processing have been found in aphasia (Luria, 1973; Pribam, 1971). These disruptions can be related to syntagmatic and paradigmatic processing in the developmental literature (Jarman, 1980). Although different measures were used in the developmental language and aphasia literature, yielding different evidence, the same processes appear to be affected in both normal and dysfunctional language. Luria's neuropsychological model indicates that these language processes take place in the second block of the brain (Luria, 1973, 1982). The cognitive processes that take place in this block of the brain, simultaneous and successive processing, have been related to the disruptions in language processing that occur in aphasia (Luria, 1973; 1982). Syntagmatic aphasia is believed to result from a disruption in successive processing, while paradigmatic aphasia is believed to result from a disruption in simultaneous processing.

These same cognitive processes that are related to language processes have also been found to be related to reading disabilities (Kirby and Das, 1977; Cummins and Das, 1977). Reading has been shown to be dependent on both simultaneous and successive processing, and children with reading difficulties have been found to have deficiencies in these processes. Successive processing is felt to be more important in early reading development; simultaneous processing is believed to relate more to reading comprehension (Cummins and Das, 1977).

The theoretical basis underlying the language-reading disabilities relationship has been found in the cognitive processing literature. Simultaneous and successive processing provide the necessary link between dysfunctional language and dysfunctional reading. Evidence of the language processing abilities of reading disabled students, when compared with normal readers, will provide support for this relationship.

The subject identification of reading disabled students has been discussed in the review of the literature. Criticism has been made of studies which do not adequately define their reading disabled population on the basis of discrepancy criteria (Reynolds, 1984), or which include low achieving readers in the population (Ysseldyke *et al.*, 1982; Weener, 1981). Four criteria have been deemed necessary for adequate identification (Reynolds, 1984). They include a regression model, a reliable simple difference score between aptitude and achievement, relative infrequency of the difference score in the general population, and use of standard scores. Research being conducted with reading disabled youngsters must use these criteria for subject identification.

However, thorough investigation of the differences between students with reading difficulties necessitates investigation of the language processing abilities of low achieving readers as well as reading disabled students. The same identification procedures of the regression model (Reynolds, 1984) can be incorporated to select subject groups of low achieving, reading disabled and normal readers.

Task selection is also a variable which must be considered in the investigation of language processes in reading disabled students. As indicated in the review of the literature syntagmatic and paradigmatic processing may be investigated by either a clinical interview method, as per Luria, or by word association tasks, as per the developmental literature. The word association tasks are more appropriate to the population of reading disabled students, most of whom would not have language disorders as severe as the aphasic population. However the review of the literature has indicated the lack of consistent comparison that has been made between the various word association tasks. Nelson (1977) has indicated that stimuli must be used which will elicit different forms of language responses. Research which will be able to compare similar processes over different tasks within the same subject group will further the knowledge in the language literature.

The relationship between language and reading disabilities has been difficult to investigate because of the different theoretical bases from which the two literatures arise. However, the cognitive processing literature has provided the necessary link between reading disabilities and dysfunctional language. Simultaneous and successive processes have been related to both language processes and reading. Deficiencies in language have been found to occur in the same cortical areas as these cognitive processes. Reading difficulties have been found to be dependent on these cognitive processes. Using this theoretical framework, investigations into the language processes of reading disabled students will lend further support to the language-reading disabilities relationship.

CHAPTER III. STATEMENT OF THE PROBLEM

The purpose of the present study was to investigate the relationship between language processes and reading disabilities. The literature in reading disabilities, as well as developmental and dysfunctional language, has indicated that a linguistically based theory of reading disabilities is plausible. The neuropsychological aphasia literature has identified language processes which have been associated with cognitive deficits. These same cognitive deficits have been associated with reading disabilities. The language processes in question are syntagmatic and paradigmatic processes. The investigation of the relationship between reading disabilites and language was centered around these processes. In order to address the purpose, two problems were examined.

QUESTION ONE: WHAT DIFFERENCES EXIST BETWEEN DIFFERENT WORD ASSOCIATION PARADIGMS IN THEIR ABILITY TO PRODUCE PARADIGMATIC AND SYNTAGMATIC RESPONSES WITHIN THE SAME SUBJECT GROUP?

The first problem involved the paradigms which are presently used to assess syntagmatic and paradigmatic language functioning. The developmental literature has traditionally used word association tasks or their variations for the assessment of these processes. Although some developmental differences have been found between different paradigms, little has been done to actually investigate the paradigms themselves. The literature does not address paradigm diversity, nor does it comment on the equivalence or non-equivalence of the paradigms used. The first research question of the study addressed these issues.

QUESTION TWO: DO READING DISABLED STUDENTS DIFFER IN THE WAY THAT THEY RESPOND TO SYNTAGMATIC AND PARADIGMATIC PROCESSING TASKS, WHEN COMPARED WITH LOW ACHIEVING AND NORMAL READERS?

The second problem addressed was that of the linguistic basis of reading disabilities. Although reading disabled children show clear evidence of language dysfunction, there is a need in the current literature to incorporate a suitable and theoretical model of linguistic processing to strengthen the language-reading disabilities theory. The model which incorporates both language processing and reading disabilities is that of cognitive processing. Simultaneous and sequential processing have been shown to be related to both dysfunctional language (i.e. aphasia) and dysfunctional reading (i.e. reading disabilities). This model was used as a theoretical basis to address the linguistic basis of reading disabilities.

Question one was an exploratory question. Since the relation between verbal learning paradigms is not well understood in the literature, no hypotheses could be generated prior to the study. Paradigm diversity was investigated to further the knowledge in this area, and to provide a basis by which to compare the subject groups.

Question two was exploratory as well. However, there was some limited evidence to suggest that reading disabled students may have more difficulty with paradigmatic tasks than other readers, the answer to question two was semi-confirmatory. Nevertheless, the limited knowledge that exists about these language processes in reading disabled students did not allow the formulation of a full hypothesis to either question.

CHAPTER IV. METHOD

A. SUBJECTS

Subject classification involved two phases. The first phase included the examination of a large sample accessible through the Edmonton Catholic School Division. The second phase involved the classification of three separate subject groups, drawn from the original large sample.

1. SUBJECT CLASSIFICATION (PHASE ONE)

1765 grade four students (mean age 9.6 years) in the Edmonton Catholic School Division were assessed by the school division, as part of the regular, on-going assessment program.

The reading achievement instrument used was the Canadian Test of Basic Skills (1974), multi-level edition, grade 4 level, reading comprehension subtest. Cognitive ability was measured using both verbal and nonverbal scales of the Canadian Lorge-Thorndike Intelligence Test (1967), multi-level edition, grade four level. Due to the high correlation between verbal IQ and reading, only the nonverbal IQ score was used as a measure of ability. Administration and timing of the test instruments was carried out following manual guidelines.

Initial statistical manipulation of the data involved a regression procedure, MULR10, (Harley, D., 1981, Division of Educational Research, University of Alberta), with a cross-validation procedure to ensure the stability of the population. There were no differences in IQ, gender, age or reading comprehension when the total group was split into half to cross-validate the scores. After this initial cross-checking was done, the SPSS-X multiple stepwise regression procedure was used as the method of determining the contribution of each of the independent variables of nonverbal IQ, gender, and age to reading comprehension. The regression procedure, using age, gender, and nonverbal IQ was used to predict reading achievement scores. The regression formula used for this prediction was as follows:

Predicted reading achievement = (beta weight X age) + (beta weight X gender) + (beta weight X nonverbal IQ) + constant.

The SPSSX regression formula produced the following values as beta weights:

Predicted reading achievement = (.006 X age) + (.053 X gender) + (.572 X nonverbal IQ) + 33.743.

The actual reading achievement score for each of the 1765 subjects was then subtracted from the predicted reading achievement score, to arrive at a discrepancy score. The derivation of these discrepancy scores yielded the formation of three subject groups.

2. IDENTIFIED SUBJECT GROUPS (PHASE TWO)

As described in the results section (Table 2), the subject group labelled as reading disabled were those subjects with nonverbal IQ measures within one standard deviation of the mean, and discrepancy scores more than one standard deviation below the mean (s.d. 19 points below the mean). The subject group labelled as low achieving readers were those with measured nonverbal IQ's between one and two standard deviations below the mean, and discrepancy scores within one standard deviation of the mean. The control group were those students with measured nonverbal IQ scores within the normal range (i.e. within one standard deviation of the mean) and discrepancy scores within one standard deviation of the mean.

A discrepancy score of greater than 19 points was chosen as the defining characteristic of the reading disabled group, rather than one standard deviation (i.e. 16 points) that was consistent with the achievement and IQ test norms. This more stringent criteria would enable the inclusion of only those subjects who had more severe discrepancies between ability and achievement, and would differentiate more clearly between those subjects and the other subject groups.

The regression formula identified 85 students in the reading disabled group, 102 students in the low achieving group, and 816 students in the control group. The percentages of students identified as reading disabled and low achieving readers were somewhat different from those of Horn and O'Donnell (1984), who used a regression formula and discrepancy criteria for identification. They had found that 4 per cent of their sample was identified as low achieving readers, and that 5 per cent was identified as reading disabled. The current study identified 4.8 per cent of the sample as reading disabled, and 5.7 per cent as low achieving. The difference between these two studies may to due to the difference in sample size, subject age or the discrepancy criteria chosen for identification. The Horn and O'Donnell study used 218 grade one children, and a discrepancy criteria of 1.5 standard deviations. This study began with 1765 grade four children, and used a discrepancy criteria of 1.2 standard deviations.

To decrease the control group to a size comparable to the other groups, every eighth student from the list of 816 students was chosen to be part of the control group. Using this method, 102 students were identified as controls. The schools where the students attended were contacted for participation and permission to contact the parents and carry out the study during school hours. Teachers were asked to identify students for whom there was a hearing, vision, or emotional concern or whom had English as a second language. School nurses were also contacted for the hearing and vision information. Those students who were identified as having any of the sensory, emotional or second language criteria were not included in the study. The number of subjects that agreed to participate in the study was 134; 47 control, 47 low achieving and 40 reading disabled.

B. TASKS

1. SUBJECT SELECTION TASKS

As indicated, the students were administered the group reading comprehension subtest of the Canadian Test of Basic Skills, (1974), multi-level edition, grade four level, and the non-verbal scale of the Canadian Lorge-Thorndike Intelligence Test (1967), multi-level edition, grade four level, by school district personnel. Reliability measures on the Lorge-Thorndike Test range from .76 to .94 (Ogsten, 1973). Validity measures were not reported.

2. LANGUAGE PROCESSING TASKS

Language processing was assessed using four paradigms designed to measure paradigmatic and syntagmatic processes. These tasks were developed from word lists, tasks and procedures used by Ervin (1961), Entwisle and

Forsyth (1963), Jarman (1980), Riley and Fite (1974) and Denny and Ziobrowski (1972). In order to address the question of different processes occurring within task paradigms that are selective to the individual paradigms, several different paradigms were selected. The selection process involved choosing tasks and word lists that had been developed for students similar in age to those of this study. The choice of paradigms also took age into account, as certain paradigms had been shown to be more sensitive to certain ages. In addition, the use of the paradigm in the literature was an important factor. The paradigms selected for used in this study included a free word association task (Entwisle and Forsyth, 1963), a mediated free word association task (Entwisle and Forsyth, 1963; Routh and Tweeney, 1972), a closed alternative task (Ervin, 1961), and a paired association task (Jarman, 1980).

The Appendix includes all of the word lists for the four paradigms tested (Appendix A), as well as the scoring criteria for syntagmatic and paradigmatic responses. (Appendix B). In addition, the full set of instructions given to each examiner and used with each task are included (Appendix C).

a. Free Word Association Task

This task used words selected from a word list of 96 stimuli words of different parts of speech and different frequencies (Entwisle and Forsyth, 1963). On this task, the subject was asked to respond with the first word s/he thought of when the examiner read a word. Two lists of ten words each were administered. Words from each list were administered at random, until all words from both lists had been administered. This randomization was used to minimize the effect of set, i.e., that the subject would become accustomed to responding one way or another and this set would affect the score. One list was scored for syntagmatic responses, while the other list was scored for paradigmatic responses.

Responses were chosen as paradigmatic if they formed the same form class as the stimulus word (e.g., noun, verb, adjective, adverb) and if they fell within one of the categories of co-ordinate (e.g., car/truck), superordinate (e.g., apple/fruit), contrast (e.g., dark/light) or part-whole (e.g. tree/branch). Words were judged to be syntagmatic if they could grammatically precede or follow the stimulus word in a sentence, or they were derived from the stimulus word (e.g., happy/unhappy), or they were a function or property of the stimulus word (e.g., apple/eat, car/go). Responses that, with the stimulus word, formed one word, such as flower-pot or table-cloth were also judged to be syntagmatic. Clang responses were rhyming words such as in/pin, tall/mall. These were scored as zero, as were any non-English or nonsense words. Complete scoring criteria are available in Appendix B.

The maximum number of syntagmatic responses that could be obtained was ten, as was the maximum number of possible paradigmatic responses.

b. Closed Alternative Task

This task is a slightly modified version of one used by Ervin (1961). Each item on the task consists of three words, a stimulus word, a paradigmatic response word and a syntagmatic response word. The subject was asked to state which word of the two response words read by the examiner went better with the stimulus word read by the examiner. For example, the examiner might say, "Does horse go better with run or with cow?" Two lists of words were administered. As in the free word association task, the items were administered randomly until all items from both lists had been administered. One list was scored for syntagmatic responses, and one list was scored for paradigmatic responses. The maximum number of possible syntagmatic responses was ten, as was the maximum number of possible paradigmatic responses.

c. Paired Association Task

This task was developed by Jarman (1980), and was used without modifications. The task consisted of a syntagmatic word-pair list and a paradigmatic word-pair list. Each word list consisted of ten pairs of words. The examiner read each list of paired words separately to the subject. After reading one list, the first word of each pair was read in random order to the subject. The subject responded with the word s/he thought was the paired word. The procedure was repeated for the second list. The entire procedure was repeated again for the second trial. The presentation of the word lists was randomized, as was the presentation of the word-pairs within each list. This paradigm was scored for the number of paradigmatic and syntagmatic associations learned over two trials. The maximum number of correct syntagmatic responses was twenty, as was the maximum number of correct paradigmatic responses.

d. Mediated Free Word Association Task

The words chosen for this task were taken from Entwisle and Forsyth's (1963) word list of 96 stimulus words of different parts of speech and different frequencies. Instructions for paradigmatic responding were adapted from those used by Routh and Tweney (1972).

This task was similar in design and procedure to the free word association task, with one major addition. Prior to presentation of the word lists, the students received individual training in paradigmatic responding. It included a discussion of nouns, verbs, adjectives and adverbs. These were called "thing words, doing words, what kind words and how words". Students were given practice words until they could demonstrate that they understood the task. Complete verbatim, detailed instructions are in Appendix C. The scoring procedure was identical to the free word association task (see Appendix B).

C. PROCEDURE

The paradigmatic and syntagmatic language tasks were administered to each subject. Each task was presented individually to each of the subjects, by one of four examiners. All examiners were unaware as to the subject group membership of the subjects. Three research assistants, university students, were trained by the prinicipal investigator to carry out the language processing tasks in a standardized manner. The instructions with which the tasks were administered are included in the Appendix. Each subject was seen on one occasion for a period of approximately 30 minutes.

Inter-rater reliability on scoring procedures for the free word and mediated free word association tasks was obtained using 30 sample protocols, drawn randomly from the total sample. Inter-rater reliability was between .85 and .96 (mean .92). Responses obtained for the other tasks were not "free" responses and did not require examiner interpretation as to whether they were syntagmatic or paradigmatic. In the closed association tasks, the examiner simply marked which word the subject had chosen out of two choices. In the paired associate tasks, the examiner noted which word pairs the subject remembered. On both the closed association and paired associate paradigms, the words had been assigned to a syntagmatic or paradigmatic category prior to task administration, although these categories were not known to the examiners.

Task presentation in all cases was oral, rather than written, to guard against reading ability confounding the results on the dependent variables.

Task administration order was fixed, due to the nature of the tasks themselves. The aim of task administration order was to contaminate the student's responses as little as possible, and to have students give genuine responses that were indicative of their individual processing style. The free word association tasks (one and two) were administered first, so that the subject's responses would not be contaminated by hearing other word pairs or associations. The closed association tasks (tasks three and four) were second, since they involved both a choice and a recognition process. Because tasks five and six, the paired associated paradigm, involved actual teaching of and memory for word pairs, they were administered next. Mediated free word association tasks (tasks seven and eight) were administered last in the sequence, since they involved actual teaching of paradigmatic processing.

CHAPTER V. RESULTS

A. SUBJECT IDENTIFICATION DATA

The identification data for the pooled sample of 134 students is shown in Table 1. Subject mean age was 115.35 months (s.d. 6.42), nonverbal IQ was 94.76 (s.d. 14.22), and comprehension was 83.95 (s.d. 11.63). The mean predicted comprehension score was 91.59 (s.d. 7.97), leaving a discrepancy between overall predicted and actual comprehension scores of 7.64 points.

Table 1: Sample Descriptive Statistics for Independent Variables Pooled for Group and Gender

Variables	Mean[1]	Standard Deviation
Age (months)	115.35	6.42
Non-verbal IQ	94.76	14.22
Comprehension	83.95	11.63
Predicted Comprehension	91.59	7.97
Discrepancy Comprehension	-7.64	11.93

1. n=134

Table 2 presents the classification data for the three subject groups for boys and girls, separately and pooled. This data reflects the classification system used for separating the subjects into groups, for purposes of the main analysis of the study. As indicated, the reading disabled subjects were those with nonverbal IQ measures within one standard deviation of the mean, and discrepancy scores greater than one standard deviation below the mean (i.e., more than 18 points below the mean). The low achieving group were those subjects

Table 2: Subject Group Descriptive Statistics for Independent Variables

	Boys (n=22)		Girls (n=18)		Pooled (n=40) for gender	
Variables	Mean	sd	Mean	sd	Mean	sd
Reading Disabled						
Age (months)	115.75	6.08	113.81	5.38	114.87	5.79
Non-verbal IQ	103.55	8.79	107.00	5.65	105.10	7.65
Comprehension	74.03	4.40	75.57	3.82	73.99	4.35
Predicted Comprehension	100.44	4.95	99.33	3.18	97.32	4.58
Discrepancy Comprehension	-22.98	3.01	-23.76	3.12	-23.33	3.05
	Boys (n=17)		Girls (n=30)		Pooled (n=47)	
Low Achieving						
Age (months)	118.39	7.21	117.22	6.87	117.64	6.94
Non-verbal IQ	78.29	5.05	78.50	4.40	78.43	4.59
Comprehension	82.00	8.34	80.44	8.50	81.01	8.39
Predicted Comprehension	81.47	2.84	83.29	2.48	82.63	2.73
Discrepancy Comprehension	.53	8.21	-2.85	7.50	-1.63	7.85
	Boys (n=28)		Girls (n=19)		Pooled (n=47)	
Control						
Age (months)	114.58	5.66	111.80	5.71	113.45	5.78
Non-verbal IQ	100.96	9.58	104.26	9.29	102.30	9.50
Comprehension	93.29	8.98	98.42	7.67	95.36	8.76
Predicted Comprehension	94.23	5.39	97.79	5.23	95.67	5.55
Discrepancy Comprehension	-.94	5.94	.64	6.12	-.30	6.00

with measured nonverbal IQ's between one and two standard deviations below the mean, and discrepancy scores within one standard deviation of the mean. The control group were those students with measured nonverbal IQ scores within the normal range, and discrepancy scores within one standard deviation of the mean. The mean nonverbal IQ of the reading disabled group was 105.10 (s.d. 7.65), for the low achieving group was 78.43 (s.d. 4.59), and for the control group was 102.30 (s.d. 9.50). Mean discrepancy scores for the three groups were -23.33 for the reading disabled subjects, -1.63 for the low achieving subjects and -.30 for the control group.

The data on independent measures was analyzed to determine if there were gender differences within the three subject groups. There were no differences between boys and girls in age, nonverbal IQ, or discrepancy scores. However, there were differences in both the reading disabled and the control groups on comprehension measures, and differences in all groups on predicted comprehension measures (Table 3). Since this study was a group investigation, these differences were left intact, but compensation was made for them by removal of gender differences by subsequent standardization of the dependent measures.

Table 3: t-tests for Gender on Independent Variables Within Subject Groups

Independent Variables	Reading Disabled t value df=38	Low Achieving t value df=45	Control t value df=45
Age (months)	1.06	0.55	1.65
Non-verbal IQ	-1.44	-0.15	-1.17
Comprehension	-2.17*	0.61	-2.04*
Predicted Comprehension	-2.70*	-2.30*	-2.25*
Discrepancy Comprehension	0.81	1.43	-0.88

* $p \leq .05$

Raw score means and standard deviations of the dependent measures for the total sample of 134 subjects are recorded in Table 4. The dependent measure data for the three separate subject groups is reported in Table 5.

Table 4: Sample Descriptive Statistics for Dependent Variables Pooled for Group and Gender[1]

Variables	Mean	Standard Deviation
Task 1: free word association syntagmatic	3.05	1.92
Task 2: free word association paradigmatic	5.64	1.66
Task 3: closed association syntagmatic	5.71	1.34
Task 4: closed association paradigmatic	3.43	1.37
Task 5: paired associate syntagmatic	10.24	3.89
Task 6: paired associate paradigmatic	9.04	4.17
Task 7: mediated free word association syntagmatic	2.96	1.73
Task 8: mediated free word association paradigmatic	7.05	1.92

1. n=134

The correlation matrices for the dependent measures raw data for each subject group, pooled for gender, are reported in Tables 6, 7 and 8. The effect of controlling, or explicitly restricting the ranges of IQ and achievement during the subject selection process is evident in these matrices. By limiting subjects to those within a certain range of IQ and achievement, the variability that could occur within IQ and achievement, two very generalized independent variables, was explicitly restricted.

As a consequence of this, the range of scores that could be expected to occur on the dependent measures may have been implicitly restricted. The degree

Table 5: Subject Group Descriptive Statistics for Dependent Variables

	Boys (n=22)		Girls (n=18)		Pooled (n=40) for gender	
Variables	Mean	sd	Mean	sd	Mean	sd
Reading Disabled						
Task 1	3.14	2.27	2.72	1.93	2.95	2.11
Task 2	5.73	1.21	5.56	1.42	5.65	1.30
Task 3	5.32	1.36	6.17	1.10	5.70	1.31
Task 4	3.77	1.51	2.89	1.91	3.38	1.74
Task 5	9.45	3.56	11.06	3.98	10.18	3.79
Task 6	9.41	3.40	9.44	4.48	9.43	3.87
Task 7	3.05	1.53	2.83	1.86	2.95	1.66
Task 8	6.46	1.44	7.17	1.80	6.83	1.62
	Boys (n=17)		Girls (n=30)		Pooled (n=47)	
Low Achieving						
Task 1	3.47	2.03	3.50	2.11	3.49	2.06
Task 2	5.24	1.52	5.57	1.89	5.45	1.76
Task 3	5.88	1.73	5.07	1.36	5.36	1.54
Task 4	4.00	2.09	3.30	1.56	3.55	1.78
Task 5	9.00	3.93	9.99	4.39	9.57	4.21
Task 6	7.06	4.51	8.67	3.83	8.09	4.11
Task 7	2.65	1.93	3.30	1.42	3.06	1.63
Task 8	6.71	1.96	6.63	2.50	6.66	2.30
	Boys (n=28)		Girls (n=19)		Pooled (n=47)	
Control						
Task 1	3.00	1.67	2.21	1.34	2.68	1.52
Task 2	5.50	2.03	6.32	1.46	5.83	1.85
Task 3	6.07	0.90	6.05	1.27	6.06	1.05
Task 4	3.06	1.17	3.84	1.83	3.36	1.51
Task 5	10.43	3.95	11.74	2.94	10.96	3.60
Task 6	7.96	3.75	12.16	4.10	9.66	4.38
Task 7	2.79	1.45	3.00	2.47	2.87	1.91
Task 8	7.29	1.61	8.11	1.52	7.62	1.61

Task 1: free word association syntagmatic
Task 2: free word association paradigmatic
Task 3: closed association syntagmatic
Task 4: closed association paradigmatic
Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 7: mediated free word association syntagmatic
Task 8: mediated free word association paradigmatic

Table 6: Pearson Correlation Coefficients of Dependent Variable Raw Data for Reading Disabled Group (n=40)

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.072	1.00						
3	-.089	.134	1.00					
4	-.114	-.226	-.198	1.00				
5	.264*	-.129	.006	-.010	1.00			
6	-.104	-.062	-.071	-.170	.154	1.00		
7	.204	-.056	-.102	-.100	-.068	-.208	1.00	
8	-.251	.203	-.086	.024	.009	.197	-.061	1.00

* $\underline{p} \leq .05$

Table 7: Pearson Correlation Coefficients of Dependent Variable Raw Data for Low Achieving Group (n=47)

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.260*	1.00						
3	.080	-.053	1.00					
4	.061	.003	-.226	1.00				
5	.062	-.103	-.147	.137	1.00			
6	-.105	-.099	-.005	.032	.144	1.00		
7	.113	-.132	-.053	.018	-.100	-.328*	1.00	
8	-.239	.287*	.183	-.097	.243*	-.008	.099	1.00

* $\underline{p} \leq .05$

Table 8: Pearson Correlation Coefficients of Dependent Variable Raw Data for Control Group (n=47)

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.508*	1.00						
3	-.028	.174	1.00					
4	-.043	.054	-.207	1.00				
5	-.066	-.178	.334*	.043	1.00			
6	-.040	-.032	-.123	.312*	.090	1.00		
7	.166	.062	.026	-.157	.044	.151	1.00	
8	-.478*	.410*	-.088	.166	-.037	.015	-.378*	1.00

* *p*≤.05

Table 9: Pearson Correlation Coefficients Between Independent and Dependent Variables (n=134)

Task	Non-Verbal IQ	Reading Comprehension
1. free word association syntagmatic	-.141*	-.206**
2. free word association paradigmatic	.071	.089
3. closed association syntagmatic	.212**	.141*
4. closed association paradigmatic	-.011	.083
5. paired association syntegmatic	.213**	.166*
6. paired association paradigmatic	.226**	.181*
7. mediated free word association syntagmatic	.238**	.181*
8. mediated free word association paradigmatic	.229**	.101

* *p*≤.05
** *p*≤.01

of this restriction is determined by the amount of correlation between the two sets of variables. Table 9 illustrates the correlations between the independent variables of IQ and reading achievement (i.e. reading comprehension) and the dependent variables, the language tasks, for the total sample. Non-verbal IQ correlated significantly ($p<.05$) with six of the eight language tasks, and achievement correlated with five of them. As a result of this correlation between independent and dependent measures, the scores on the dependent measures were implicitly restricted. This restriction of range can result in a smaller correlation than might be expected in the general population (Tabachnick & Fidell, 1983). The correlations between the dependent measures, illustrated in Tables 6, 7 and 8 are, therefore, quite low.

In the reading disabled group (Table 6), there is only one significant correlation, between syntagmatic tasks one and five. Task one is the free word association task, and task five is the paired associate task. The syntagmatic process could be assumed to be responsible for this positive correlation. It is interesting to note that this is the only correlation of significance in the reading disabled group, while the other subject groups had at least four significant correlations. The correlation found in the reading disabled group is also not a comparsion found in either of the other subject groups.

In the low achieving group (Table 7), there are four significant correlations. Task one, the free word syntagmatic task, is correlated negatively with task two, the free word paradigmatic task. Task eight, the mediated free word paradigmatic task is also correlated positively with task two, the free word paradigmatic task, and task five, the paired associate syntagmatic task. This latter correlation may appear unusual, but is illustrative of a memory/learning interaction, i.e. as one's memory increases (task 5), so does one's ability to benefit from teaching (task 8). The other significant correlation is almost the opposite to this last association. Task six, the paired associate paradigmatic, and task seven, mediated free word association syntagmatic are correlated negatively. Again, this may be illustrative of the memory/learning interaction, as well as the differences between the syntagmatic-paradigmatic processes.

There are five significant correlations in the control group (Table 8). Some of these are similar to those for the low achieving group. For instance, task eight, the mediated free word association task (paradigmatic), correlates negatively with task one (free word association syntagmatic) and positively with task two (free word association paradigmatic). Other positive correlations were found between the closed association syntagmatic and the paired associate syntagmatic tasks, three and five, and between tasks four and six, the closed association and paired associate paradigmatic tasks. The two mediated free association tasks, seven and eight, were correlated negatively. These correlations all appear to follow the process differences expected between syntagmatic and paradigmatic tasks, i.e. the syntagmatic tasks correlate positively, as do the paradigmatic. Similarly, the syntagmatic and paradigmatic tasks correlate negatively with one another. The performance of the control group in this regard may be presumed to be indicative of normal developmental processes.

B. FACTOR ANALYSIS

The first step in exploring question one, "What differences exist between different word association paradigms in their ability to produce paradigmatic and syntagmatic responses within the same subject group?" was to determine whether the groups should be analyzed separately, or whether they were sufficiently similar to allow them to be pooled together. Differences were explored in three areas, i.e. variance within the subject groups, mean differences between the subject groups, and gender differences within the subject groups. Multivariate and univariate tests were applied to the data.

A multivariate analysis of variance (MANOVA) was carried out to test the difference between the variance-co-variance matrices and the mean differences between the three subject groups. The OWMAR program on the University of British Columbia mainframe computer was used for this purpose.

Firstly, the assumption of the homogeneity of variance-covariance was tested, to determine if the variance within the subject groups was similar enough to allow the groups to be pooled. In addition, this test was used as a preliminary measure to the MANOVA which follows. Kirk (1982) has reported that, for samples of unequal size, moderate violations of this assumption (i.e., using groups with heterogenous variance) can have a marked effect on the significance test. The result of the Barlett-Box Homogeneity of Dispersion Test ($F(72,45716.9)=1.202$, $p>.10$) indicated that the assumption of the homogeneity of variance-covariance was tenable for the samples used in this study.

Secondly, the mean differences between the three groups were tested. The multivariate analysis of variance test, using the eight dependent variables and three groups, employed two statistics as tests of the null hypothesis. The likelihood ratio test was non-significant ($F(16,248)=1.25$, $p>.20$), as was the Maximum Latent Root Approach test, indicating that there were no mean differences between the three groups on the eight dependent variables.

Since OWMAR is an omnibus test of significance, there may have been minor gender differences hidden in the data which were not analyzed. The third set of tests to be undertaken involved separate analyses of each of the dependent measures within each of the subject groups, to determine if there were any gender differences that might confound the results. 24 t-tests, carried out on gender by task differences for each group are recorded in Table 10. Only two areas of difference were found, which could be attributed to chance. Differences between boys and girls were significant in task 3, the closed association syntagmatic task, in the learning disabled group (df=1, f=4.5693, p=.039). Significant gender differences were also found in task 6, the paired associate paradigmatic task, in the control group (df=1, f=13.1444, p=.0007).

Table 10: t-tests for Gender on Dependent Variables Within Subject Groups

Dependent Variables	Reading Disabled t value df=38	Low Achieving t value df=45	Control t value df=45
Task 1	0.375	0.002	3.202
Task 2	0.172	0.382	2.274
Task 3	4.569*	3.197	0.004
Task 4	2.680	1.705	3.398
Task 5	1.804	0.490	1.512
Task 6	0.001	1.684	13.144*
Task 7	0.158	1.762	0.140
Task 8	1.482	0.011	3.068

* $\underline{p} \leq .05$

To eliminate even these minor gender and group differences which could affect the data somewhat, the raw data on boys and girls within each group was scaled separately into t-scores, using the generally accepted distribution of a mean of 50 and a standard deviation of 10. The computer program used to scale the data was DEST03 Division of Educational Research Services, University of Alberta). The boys and girls within each subject group were then pooled to re-form their original subject group of reading disabled, low achieving and control.

1. CORRELATION MATRICES

Correlation matrices were developed from the newly scaled data, and are reported in Tables 11, 12 and 13, for future reference. As expected the correlation patterns of the scaled data were not substantially different from those of the raw data. The new matrices reported correlations that were all low to moderate, as were the original correlations, due to the restriction of range of IQ and achievement within each subject group which was previously discussed.

The similarities between the correlation matrices is striking, particularly in terms of tasks one, two and eight from the free word and mediated free word paradigms. This is expected, since the variance-co-variance test indicated no significant differences between the three groups. In all three of the correlation matrices, either some or all of these tasks, i.e. one, two and eight, are correlated. These relationships will undoubtedly be important in the factor analysis to follow.

The previous multivariate analysis had indicated that there were no significant mean differences between the performance on dependent measures of the three subject groups, and that there were no significant differences between

Table 11: Pearson Correlation Coefficients of the Dependent Variables for Reading Disabled Group, With Mean Gender Differences Removed

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.080	1.00						
3	-.076	.167	1.000					
4	-.156	-.261	-.127	1.000				
5	.296	-.090	-.083	.051	1.000			
6	-.106	-.055	-.077	-.085	.145	1.000		
7	.203	-.045	-.086	-.152	-.030	-.200	1.000	
8	-.237	0.227	-.166	.070	.016	.199	-.046	1.000

Table 12: Pearson Correlation Coefficients of the Dependent Variables for Low Achieving Group, With Mean Gender Differences Removed

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.265	1.000						
3	.067	-.005	1.000					
4	.104	-.003	-.292	1.000				
5	.058	-.147	-.150	.187	1.000			
6	-.083	-.122	-.028	.088	.128	1.000		
7	.144	-.141	.117	.088	-.113	-.316	1.000	
8	-.209	.268	.205	-.117	.240	-.003	.112	1.000

Table 13: Pearson Correlation Coefficients of the Dependent Variables for Control Group, With Mean Gender Differences Removed

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.470	1.000						
3	-.033	-.186	1.000					
4	.027	-.018	-.074	1.000				
5	-.023	-.219	.362	.009	1.000			
6	.119	-.156	-.142	.216	.007	1.000		
7	.213	.059	.071	-.085	.009	.112	1.000	
8	-.435	.398	-.091	.071	-.098	-.122	-.400	1.000

the variance-co-variance matrices of the three groups. Subsequent data manipulation standardized the data to remove any minor differences between the groups. Since the groups were sufficiently similar in means and variance, and minor gender differences were removed, the three subject groups were now pooled for future analysis, and a new correlation matrix was formed from the standardized, pooled data. The pooled correlation matrix, representative of the total subject sample, is illustrated in Table 14. The low correlations between the variables is the result of the restriction of range, which has been discussed, and of the pooling procedure. By pooling the three groups, even minor individual differences that may have been present in the separate correlation matrices have been erased.

Table 14: Pearson Correlation Coefficients of the Dependent Variables for Total Subject Group, Corrected for Gender and Pooled for Gender and Group (n=134)

Task	1	2	3	4	5	6	7	8
1	1.000							
2	-.286	1.000						
3	-.010	-.018	1.000					
4	.000	-.085	-.166	1.000				
5	.100	-.155	.050	.084	1.000			
6	-.019	-.114	-.083	.082	.090	1.000		
7	.186	-.042	.040	-.044	.046	-.131	1.000	
8	-.297	.302	-.009	.005	.055	.015	-.115	1.000

As in the separate subject group matrices, the tasks one, two and eight play a significant role in the relationships within the pooled group. Tasks one and two, the free word association tasks, are correlated negatively, as an indication of the different processes being used in tasks within the same paradigm. The paradigmatic tasks two and eight, illustrative of the mediated and non-mediated free word association paradigm, are positively related, as are their syntagmatic counterparts, tasks one and seven. Similarly, tasks one and eight, illustrative of the syntagmatic and paradigmatic differences within those paradigms, are negatively correlated.

2. PRINCIPAL COMPONENT ANALYSIS

There are three major decisions to be made in factor analysis, namely, the choice of the model, the number of factors to be extracted, and the rotation procedure.

The decision about the choice of the model is dependent upon the purposes of the study. The two major uses of factor analysis are exploratory and confirmatory (Tabachnick and Fidell, 1983). Exploratory factor analysis is usually used to reduce the number of variables and to formulate hypotheses about the reduced data set, while confirmatory factor analysis usually occurs in response to hypotheses that are already formulated. The analysis used in this research is for exploratory purposes, to analyze the potential underlying relationships between the eight dependent variables, and to draw some tentative hypotheses that may be tested with future research. In order to do this by extracting the maximum variance from the data, the principal component analysis model was chosen.

A second decision in factor analysis is the consideration of the number of factors to be extracted. Certainly, a two-factor solution could be postulated, which would include paradigmatic and syntagmatic components. However, since this is an exploratory study, interpretation of an adequate number of factors in important. On the basis of the SCREE test (Cattell, 1966), a four factor solution was chosen.

The third decision is the method of rotating the data. The theoretical underpinnings of this study imply that the syntagmatic and paradigmatic language processes are theoretically tied to simultaneous and successive processes, which in turn are said to be functionally independent of one another in neurological terms.

Therefore, the expression of the factors which arise from the data analysis of paradigms measuring syntagmatic and paradigmatic language processes would be orthogonal, i.e. uncorrelated, factors.

However, as a further investigation, the data was also rotated obliquely, using the Promax method, to see if the two procedures produced different results. There was no difference between the orthogonal and the oblique solutions. The orthogonal solution will be reported.

The method of choice of orthogonal rotation is the varimax rotation (Tabachnick and Fidell, 1983). It maximizes the variance of the loadings across the variables within factors, thereby improving the interpretability of the factors.

The principal component analysis with varimax rotation yielded the factor matrix illustrated in Table 15. Moderate to high loadings emerged within the factor matrix, with each task loading on only one of the four factors. Both of the free word association tasks (one and two), with the mediated free word paradigmatic task (task eight), loaded on factor one. Factor two had loadings from two different paradigms, the paired associate paradigmatic task (task six), and the mediated free word syntagmatic task (task seven). The paired associate task loaded negatively. The syntagmatic and paradigmatic closed association tasks, three and four, loaded on factor three, with task three as a negative loading. Factor four had one strong positive loading from task five, the paired associate paradigmatic task.

It was anticipated that there might be two factors, illustrative of syntagmatic and paradigmatic processing. The emergence of a four factor solution suggests that the paradigms studied are not measuring only these two processes, or that there are different levels or types of these processes. Before analyzing

Table 15: Principal Components Analysis With Varimax Rotation for Pooled Group, Corrected for Gender

	Factor 1 (Long-term Paradigmatic)	Factor 2 (Long-term Syntagmatic)	Factor 3 (Paradigmatic Recognition)	Factor 4 (Short-term Syntagmatic)
Task 1	-.685	.249	.036	.131
Task 2	.717	.183	-.020	-.232
Task 3	.002	.080	-.772	.270
Task 4	-.005	-.009	.745	.283
Task 5	-.063	-.063	.003	.896
Task 6	-.155	-.737	.120	.072
Task 7	-.229	.723	.035	-.002
Task 8	.752	-.024	.044	.269
% Common Variance	32.08	23.10	23.07	21.76
% Total Variance	20.35	14.66	14.64	13.80

Task 1: free word association syntagmatic
Task 2: free word association paradigmatic
Task 3: closed association syntagmatic
Task 4: closed association paradigmatic
Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 7: mediated free word association syntagmatic
Task 8: mediated free word association paradigmatic

what these factors might indicate, it might be useful to look at the four paradigms once again. Both the free word association (tasks one and two) and mediated free word paradigms (tasks seven and eight) required the subject to generate a response to a stimulus word. In the mediated task, the subject was taught to respond paradigmatically, but in the non-mediated paradigm, the subject had received no instruction on type of response required. The closed association paradigm was a recognition test, whereby the subject was given two choices of word pairs (one syntagmatic, the other paradigmatic), and was asked which pair "went together" better. Finally, the paired associate paradigm involved memory to a large degree. The subject was required to listen to syntagmatic and paradigmatic word-pair lists. The subject was then asked to respond to a stimulus word with the response word from the original word pair. In all the paradigms, the odd-numbered tasks were syntagmatic, and the even-numbered ones were paradigmatic.

The factor loading matrix, based on the pooled data, has four factors which illustrate the complexity of language processing, as measured by the chosen paradigms. This complexity included the free response, recognition, memory and teaching components of the paradigms.

Factor one, representing the most variance in the principal components analysis, is clearly a long-term paradigmatic factor, with positive loadings on both the non-mediated and mediated free association paradigmatic tasks (tasks two and eight) and a negative loading on the non-mediated free association syntagmatic task (task one). Both of the free response paradigmatic tasks require the production of paradigmatic responses. Task two requires spontaneous production, while task eight, the mediated free response task, requires paradigmatic production after instruction. Task one, the non-mediated syntagmatic task, requires spontaneous production of syntagmatic responses. Long-term memory is implicated in all of these components. Even when mediation aids the process, retrieval of information from long-term memory is needed to form the semantic relationships required. Indeed, the spontaneous and instructional components of the paradigms within factor one define this factor as one which is indicative of the ability to process paradigmatically with and without instruction. Because of the free response nature of the paradigms within factor one, loadings on these tasks are probably indicative of a stronger paradigmatic factor than is possible with the other paradigms. Since both the mediated and the non-mediated tasks loaded on this factor, it is illustrative of abilities that have been learned, and can be taught.

Factor two, comprised of a negative loading on the paired associate paradigmatic task (task six) and a positive loading on the mediated free word syntagmatic factor (task seven), is a factor which is also influenced strongly by learning and memory. It appears to be a measure of long-term syntagmatic processing. Memory is initially implicated by the presence of the paradigmatic paired associate task six, which is primarily a memory task. However, both memory and learning processes are implicated in the mediated syntagmatic task seven. The responses to this particular task follow immediately after subjects have been taught to respond paradigmatically. If the mediation or teaching has been successful, one would expect a lessened level of syntagmatic responses. A loading on task seven indicates the presence of syntagmatic processing, even after paradigmatic mediation. The syntagmatic responding would have to rely on retrieval from long-term memory store for the semantic relationships already formed, or for the method of processing required to form new syntagmtic relationships. The negative loading of task six, combined with the positive loading of task seven, provides an interesting inverse relationship, illustrative of the effect of memory on learning. In effect, the inverse relationship indicates that, as one's memory decreases (i.e., task six), syntagmatic responses increase (i.e., task seven), indicating a decrease in the effect of mediation. This factor, therefore, may be regarded as a long-term syntagmatic factor.

Factor three would appear to be a paradigmatic factor, with a strong negative loading on the syntagmatic task three, and a strong positive loading on the paradigmatic task four. However, since the tasks involved are the closed association tasks, which involve recognition rather than a free response, this factor may be more indicative of an ability to recognize, rather than produce, paradigmatic structures. Following learning theory, this level of recognition would occur prior to production. Factor three will be described as a paradigmatic recognition factor.

The last factor, factor four, is indicative of short-term syntagmatic processing, since it consists of one positive loading on the syntagmatic paired association task five. This task uses memory as a primary component of fulfilling the task requirements. However, since only one variable loads on this factor, the factor may be insufficiently defined, and will be discussed within that context.

The free word association, closed association, paired associate and mediated free word association paradigms have been shown to measure different types of syntagmatic and paradigmatic processing. Recognition, memory and learning have been shown to be important components of the paradigms that must be taken into account in the study of syntagmatic and paradigmatic language processing.

The best reflection of a student's method of processing either syntagmatically or paradigmatically would appear to be the free word association paradigm, in which the subject must spontaneously, without any pre-set word lists or instruction, produce a response. Perhaps the next paradigm that is indicative of some form of syntagmatic and paradigmatic processing is the closed association paradigm. This paradigm, however, may only be useful as a measure of how well a subject recognizes certain word pairs as being syntagmatic or paradigmatic. The measure of the production aspect of responses is probably best left to the word association paradigm.

The effect of mediation, or instruction, on syntagmatic and paradigmatic responding, is an important component in this research. The paradigm requiring responses only after the student has received instruction in paradigmatic responding is the mediated free word association paradigm, represented in this research by tasks seven and eight. The syntagmatic and paradigmatic components of this paradigm load individually on separate factors, indicative of the processing requirements. The paradigmatic task loads on the long-term paradigmatic factor, indicating that mediation strategies can enhance the production of paradigmatic responses. In addition, the syntagmatic task loads on the long-term syntagmatic factor, indicating the importance of the relationship between mediation and memory. The paradigm that is most strongly affected by memory processing is the paired associate paradigm, represented by tasks five and six. As well as being represented in the long-term syntagmatic factor, this paradigm is responsible for a the short-term syntagmatic factor. These results indicate that memory must be fully assessed as a major component of the paired associate paradigm, and that different levels of processing must be taken into account when using this paradigm.

In summary, there were four distinct factors which have been interpreted as long-term paradigmatic, long-term syntagmatic, paradigmatic recognition, and short-term syntagmatic. It is not possible to examine the differences between these four factors without some method of standardization. Therefore, in order to examine the differences in processing based on these four factors, factor scores were developed.

3. FACTOR SCORES

To answer question two, i.e., "Do reading disabled students differ in the way that they respond to syntagmatic and paradigmatic processing tasks, when compared with low achieving and normal readers?", it was necessary to compare performance and processing differences between the groups on each of the factors. The factor matrix illustrated in Table 15 represents the total group of 134 subjects. To further standardize the data to enable comparison of the between factor differences for each of the subject groups, factor scores were generated for each subject in the total pooled sample, using a distribution of a mean of 50 and a standard deviation of 10. Factor scores are estimates of the scores each subject would have received on each factor, if it were possible to measure it directly. The statistical program used for this procedure was FACT23 (Division of Educational Research, University of Alberta). For each subject group, the factor matrix represented in Table 15 was applied to the raw data, the means of which are represented in Table 5. For each subject, the scores of the tasks which made up each factor were converted into one factor score, thereby generating four standardized factor scores for each individual.

4. ANALYSIS OF VARIANCE

A two way analysis of variance with repeated measures was used to compare the factor scores of the three groups. The program used for this comparison was ANOV26 (Division of Educational Research, University of

Alberta). Using a 3 (Groups) X 4 (Factors) repeated measures design, in which the first factor was a between-subjects factor, and the last factor was a within-subjects (repeated) factor, the factor scores from each subject group were compared to analyze the differences between the groups on each factor. There was no main effect due to factors, of course ($df=3$, $F=.001$, $p<1.000$), since the factor scores were standardized with a mean of 50 and standard deviation of 10. In addition, as expected from the results of the original multivariate analysis, there was no group main effect ($df=2$, $F=.519$, $p<.596$), indicating no performance differences. However, the interaction of group and factors, indicated that there may be some minor processing differences between the groups. The interaction effect was marginally significant ($df=2$, $F=1.882$, $p<.08$), and the pattern of the interaction, as illustrated in Figure 2, indicated some interesting differences between the factor profiles of the subject groups.

The distinctive profiles of the subject groups in Figure 2 were plotted from the factor score means in Table 16. The low achieving and control groups

Table 16: Factor Score Means of Subject Groups

Subject Groups	Factor 1 (Long-term Paradigmatic)	Factor 2 (Long-term Syntagmatic)	Factor 3 (Paradigmatic Recognition)	Factor 4 (Short-term Syntagmatic)
Reading Disabled	49.456	49.170	49.711	49.353
Low Achieving	48.214	51.500	51.957	48.261
Control	52.248	49.206	48.290	52.290

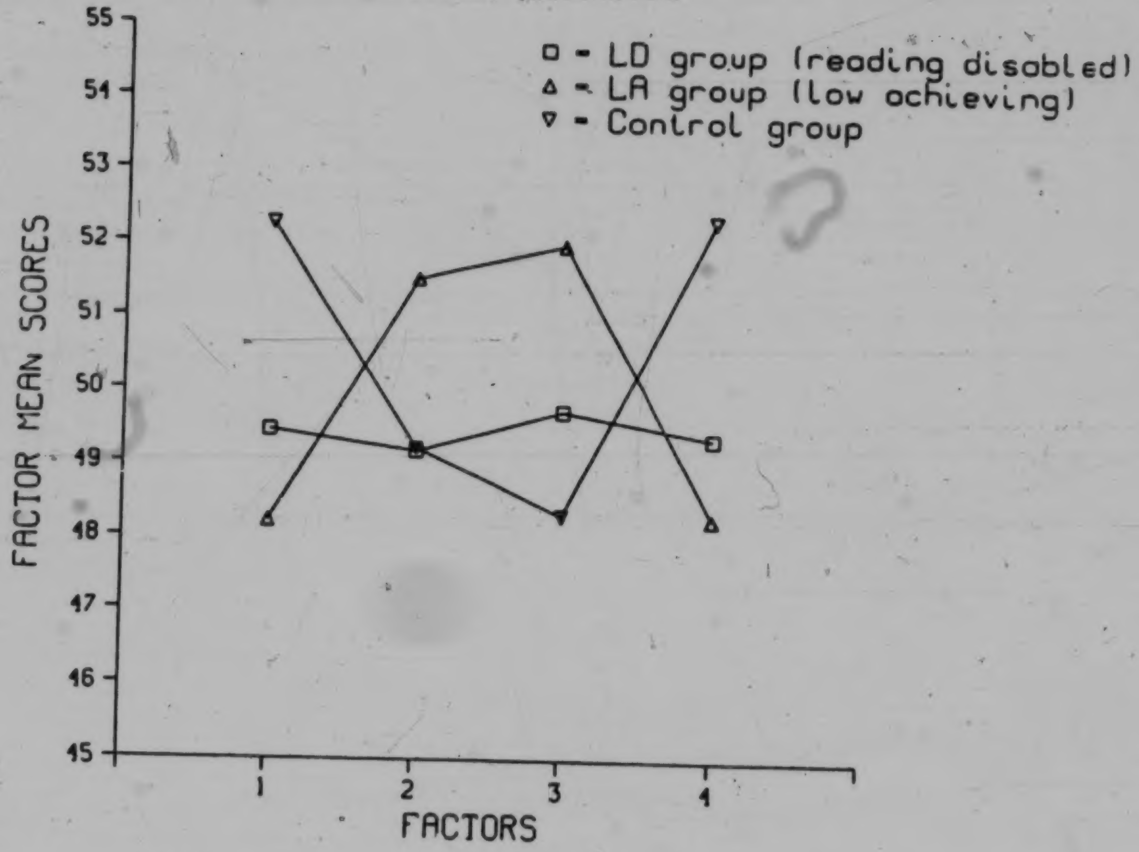

Figure 2: Analysis of Variance Differences Between Groups on Factors

Factor 1: Tasks 1, 2, 8 (Long-term Paradigmatic)
Factor 2: Tasks 6, 7 (Long-term Syntagmatic)
Factor 3: Tasks 3, 4 (Paradigmatic Recognition)
Factor 4: Task 5 (Short-term Syntagmatic)

Task 1: free word association syntagmatic
Task 2: free word association paradigmatic
Task 3: closed association syntagmatic
Task 4: closed association paradigmatic
Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 7: mediated free word association syntagmatic
Task 8: mediated free word association paradigmatic

are clearly distinctive from one another, and in fact, one is almost the mirror image of the other. The reading disabled group shows a completely unique factor pattern relative to the other two groups, indicative of processing differences between the reading disabled group and the other subject groups.

The four factors have been labelled as long-term paradigmatic, long-term suntagmatic, paradigmatic recognition, and short-term syntagmatic. Factor one, labelled long-term paradigmatic, was comprised of a positive loading on the paradigmatic free word and mediated free word association tasks (tasks two and eight), and a negative loading on the syntagmatic free word association task (task one). A high performance on factor one requires that a subject respond paradigmatically both with and without instruction. The control group perfomance, higher than either of the other two groups, would indicate that subjects classified within the average range on IQ and reading achievement are efficient paradigmatic processers. Since this factor also includes the mediated paradigmatic task, higher performance may also be an indication of the control group's increased ability to benefit from mediation, relative to the other two subject groups.

The opposite view is held for the low achieving group, classified within the below average range on both intelligence and reading achievement measures. This group responds much less efficiently on the paradigmatic factor, as might be expected.

The most interest, however, is generated by the reading disabled group, who follow neither the control or the low achieving group pattern. The reading disabled subjects respond more efficiently than the low achieving group, but less efficiently than the control group on the paradigmatic factor. The reason for these differences on this factor may be related to either the memory or the mediational aspect of this factor.

Comparison between mean scores for task two, the non-mediated task, and task eight, the mediated task, would indicate that all groups benefitted somewhat from the mediation. The low achieving group mean increased to 6.66 (s.d. 2.30), a difference of 1.21 between tasks two and eight, and the reading disabled group mean increased to 6.83 (s.d. 1.62), a difference of 1.18. However, the control group mean increased to 7.62 (s.d. 1.61), a difference of 1.79 between the two tasks. The control group would appear to benefit slightly more from mediation than either of the other two groups.

The reading disabled group is capable of using paradigmatic processing, both spontaneously, and when taught to do so. However, it does not do so quite as efficiently as the normal readers represented by the control group in this study. This discrepancy lends credence to the language-reading disabilities relationship, which supposes that reading disabled students may also show some language dysfunction, relative to normal readers. The performance of the reading disabled group, however, is not discrepant enough to predict language dysfunction within this group, but is merely suggestive of differences between reading disabled students and normal readers.

The reading disabled and control group show almost identical performance on factor two, labelled as long-term syntagmatic. The similar performance of the two groups sets this factor apart as being able to produce normal performance within the reading-disabled group. This factor is comprised of two tasks — the paired associate paradigmatic task (i.e., six), requiring memory, and the mediated free word association syntagmatic task (i.e., seven), preceded by paradigmatic training. Since the syntagmatic task loads positively, and the paradigmatic task loads negatively, a high performance on this factor indicates a) less efficient memory combined with b) lessened ability to benefit from teaching. Similarly, a low performance on this factor would indicate the positive effect of mediation on memory processes.

The reading disabled group's performance on factor two, therefore, may be indicative of the positive effect of mediation on this subject group. Their ability to use the mediational strategies and to combine them with memory strategies, would appear to be average, similar to the control group. Conversely, the low achieving group are more deficient on both memory and mediation, resulting in a higher performance on this factor, which is indicative of the interaction between poor memory and decreased ability to benefit from mediation.

Factor three, which loads negatively on the syntagmatic closed association task and positively on the paradigmatic closed association task, presents a rather unusual profile. This factor has been labelled as a paradigmatic recognition factor, due to the nature of the tasks, which do not require production of either a paradigmatic or syntagmatic response, but only recognition of which words "go better together. On this factor, a reversal of the low achieving and control group was seen. The low achieving group, which had previously scored rather low on the paradigmatic factor one, now performed at a much higher level, relative to the control group, indicating that they were making more efficient use of paradigmatic recognition strategies than either the control or the reading disabled groups. Again, the mirror image between the control and the low achieving groups is remarkable. An analysis of the reason for this seemingly differential performance requires an analysis of the paradigm itself. The closed association task requires that the child is asked "Does (a) go better with (b) or (c)?", with a) as the stimulus word, and b) and c) as the syntagmatic and paradigmatic response choices.

The raw data is somewhat illustrative of the difference between this type of a recognition task, and a production task, such as the free word and mediated free word association tasks. In the free response paradigms, the paradigmatic raw scores (tasks two and eight) were clearly higher than the syntagmatic raw scores (tasks one and seven). This trend is consistent for all three subject groups, as well as the total subject group (see Tables 4 & 5). However, on the recognition paradigm, the trend is reversed, i.e., the syntagmatic scores (task three) are higher than the paradigmatic scores (task four) for the overall group, and for the individual subject groups.

The control group's lowered performance on this factor may be indicative of a different understanding of the instructions than what the examiner intended. What the control group may be doing is choosing to respond syntagmatically, even though they are fully cognizant of and capable of producing paradigmatic responses, as shown by the production paradigms. The phrase "go better with" may actually set up some cognitive dissonance in this group, as they struggle with their own capability of paradigmatic responding, and their understanding of the demands of the recognition paradigm. They may resolve this dissonance by a syntagmatic resolution of the instructions.

The reading disabled group performance on this factor is unique from that of both the low achieving and the control groups, perhaps indicating a unique resolution of the cognitive dissonance provided by this paradigm. The low achieving group, on the other hand, does not appear to have this level of cognitive dissonance, and respond paradigmatically to the instructions, indicating their recognition of paradigmatic processing.

The results on this factor are unusual and unexpected, particularly since they are in direct contrast to factor one. More research will be needed on this specific paradigm to more completely examine the underlying processes involved, and the differential responses of different subject groups.

Factor four, the syntagmatic short-term factor, clearly differentiates between the groups. As expected, the control group has better performance on this factor, and the low achieving group has the poorest performance, almost a direct reversal of factor three. However, the reading disabled group's "close to the mean" stance may indicate that memory is not as deficient as in those with lower ability. In addition, the fact that the reading disabled and control groups were comparable in performance on factor two, comprised of one memory task and one mediation task, and are farther apart on this factor, may indicate that the paired associate paradigm is a better measure of syntagmatic processing when taken on its own, than when combined with other factors. More importantly, the results of factor four may reinforce the interaction between memory and mediation observed in factor two. On the short-term syntagmatic factor, factor four, the reading disabled group's use of memory appears to be less effective than that of the control group. However, on factor two, the long-term syntagmatic factor, the reading disabled and control group performance is almost identical. The comparison of these two factors is indicative of the effective use that reading disabled students make of the mediational strategies when these are presented to them. Without such strategies, their performance, particularly on short-term memory processing tasks, may be lessened.

Overall, the profile described in Figure 2 is illustrative of the differences exhibited by the three subject groups on the four factors. The low achieving group, as expected, is almost directly the opposite of the control group. The control group shows more efficient processing on three of the four factors, i.e., long-term paradigmatic, long-term syntagmatic, and short-term syntagmatic. The recognition factor has an unusual pattern, possibly related to the instructional aspect of the paradigm. The reading disabled group profile is distinctly different from that of the other two subject groups. With the exception of factor two, the long-term syntagmatic factor, in which the reading disabled and control group performance are almost identical, the reading disabled group maintains its distinctiveness across the factors.

C. POST-HOC ANALYSES

The analysis of variance of the between factor differences of the three groups has yielded an interesting profile. The trend illustrated by this profile indicates that the three groups may perform differentially on each of the four factors. By comparing the factor structures of each of these groups, the differences between the groups may be explored further to allow a more thorough analysis of the language processing abilities and/or differences between the three subject groups.

As a first step, the total pooled sample was separated once again into the three separate subject groups. Although mean differences between groups had been controlled by removing gender differences, and by pooling the standardized data over groups, the minor differences in the correlation patterns had been retained in the data when it was pooled. The effect of these differences could be an indication of differences in processing between the groups. In order to determine the effect of these differences, it was necessary to compare the factor solutions generated by each separate subject group.

The correlation matrices for the separate subject groups have previously been reported, in Tables 11, 12 and 13. Using the same procedure as had been used for the pooled sample, i.e. principal component analysis with varimax rotation, these separate correlation matrices were factored. Once again, on the basis of the SCREE test (Cattell, 1966), a four factor solution was chosen for each group. Table 17 illustrates the factor matrices for the reading disabled, low achieving and control groups.

These separate factor solutions were compared, using a Procrustes transformation. This type of transformation is one which tries to achieve the "best fit" between two factor solutions by orthogonally rotating one onto the other. The target matrix, analagous to Procrustes bed, does not change as the input matrix tries to fit itself onto it. Although this is usually a confirmatory analysis, since one chooses the target matrix onto which to fit the rotating matrix, it is being used in this case as an exploratory method of analysis as well. In other words, there is no pre-conceived notion as to how a factor solution from one group will fit onto a factor solution from another group.

Tables 18, 19 and 20 illustrate the transformation matrices and error matrices produced when the factor pattern of one subject group was rotated against the factor pattern of another group. The transformation matrices indicate the amount of congruence between the factors in the two groups, and the error matrices indicate the degree of lack of fit between the two groups. The closer the error is to one, the greater the amount of error, and therefore, the greater

Table 17: Principal Components Analysis With Varimax Rotation for Subject Groups

Dependent Variables	Factor 1 (Long-term Paradigmatic)	Factor 2 (Long-term Syntagmatic)	Factor 3 (Paradigmatic Recognition)	Factor 4 (Short-term Syntagmatic)
Reading Disabled (n=40)				
Task 1	.762	.063	-.303	-.147
Task 2	-.241	.763	.043	.089
Task 3	-.199	.332	.202	-.708
Task 4	-.245	-.765	.110	.118
Task 5	.733	-.085	.294	.107
Task 6	.228	.105	.676	.302
Task 7	.182	.137	-.772	.196
Task 8	-.246	.223	.219	.760
Low Achieving (n=47)				
Task 1	.710	-.034	.215	-.039
Task 2	-.822	-.041	.120	-.014
Task 3	.115	.805	.127	.117
Task 4	.109	-.769	.105	.166
Task 5	.199	-.281	-.207	.780
Task 6	.127	.004	-.773	.172
Task 7	.225	.035	.798	.116
Task 8	-.400	.297	.165	.749
Control (n=47)				
Task 1	-.818	-.145	.171	.034
Task 2	.847	-.260	.176	-.082
Task 3	-.026	.804	.069	-.183
Task 4	.046	.018	-.180	.782
Task 5	-.058	.826	-.012	.109
Task 6	-.138	-.081	.209	.758
Task 7	-.024	.027	.937	.012
Task 8	.623	-.093	-.548	.018

Task 1: free word association syntagmatic
Task 2: free word association paradigmatic
Task 3: closed association syntagmatic
Task 4: closed association paradigmatic
Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 7: mediated free word association syntagmatic
Task 8: mediated free word association paradigmatic

Table 18: Procrustes Transformation and Error Matrices for Low Achieving Group on Control Group, Corrected for Gender

TRANSFORMATION MATRIX

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	-0.8843	0.3486	0.2727	0.1488
Factor 2	-0.0466	0.4408	-0.2439	-0.8626
Factor 3	0.2590	0.0392	0.9302	-0.2571
Factor 4	0.3857	0.8262	-0.0290	0.4096

ERROR MATRIX

Dependent Variables	Factor 1	Factor 2	Factor 3	Factor 4
Task 1	-0.2324	-0.3537	-0.2320	-0.0298
Task 2	0.0925	0.0515	0.2781	0.0416
Task 3	0.0352	0.3074	0.1193	0.4790
Task 4	0.0153	0.1717	-0.4902	0.0615
Task 5	-0.1424	0.2442	0.0803	-0.5357
Task 6	0.1084	-0.2389	? 0.8994	0.4734
Task 7	-0.0748	-0.1939	0.1452	0.1663
Task 8	-0.0485	-0.7098	-0.4983	0.0694

Table 19: Procrustes Transformation and Error Matrices for Reading Disabled Group on Low Achieving Group, Corrected for Gender

TRANSFORMATION MATRIX

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	0.8344	0.1130	-0.0255	0.5389
Factor 2	-0.3102	0.8792	0.1944	0.3051
Factor 3	-0.1716	0.0813	-0.9605	0.2031
Factor 4	-0.4221	-0.4557	0.1973	0.7584

ERROR MATRIX

Dependent Variables	Factor 1	Factor 2	Factor 3	Factor 4
Task 1	-0.0203	-0.2178	-0.0398	-0.2958
Task 2	-0.3393	-0.6475	-0.0107	-0.1931
Task 3	0.1198	0.1965	0.3911	0.6189
Task 4	0.1448	-0.0239	0.3298	0.4196
Task 5	-0.3433	-0.2642	0.0895	0.2700
Task 6	0.2128	-0.0314	-0.1978	-0.3493
Task 7	0.0659	0.0461	-0.0042	-0.0157
Task 8	0.2328	0.4573	0.1758	0.1926

Table 20: Procrustes Transformation and Error Matrices for Reading Disabled Group on Control Group, Corrected for Gender

TRANSFORMATION MATRIX

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1	-0.4725	0.4106	0.6455	0.4376
Factor 2	0.6905	0.3189	0.5434	-0.3554
Factor 3	0.3300	0.6519	-0.4931	0.4721
Factor 4	0.4372	-0.5520	0.2116	0.6777

ERROR MATRIX

Dependent Variables	Factor 1	Factor 2	Factor 3	Factor 4
Task 1	-0.3372	-0.3616	-0.4734	-0.0344
Task 2	0.1532	-0.3833	-0.0807	0.2140
Task 3	-0.1064	0.2573	0.2665	0.4065
Task 4	0.3706	0.3560	0.4231	0.4854
Task 5	0.2032	0.4196	-0.3167	-0.4533
Task 6	-0.4579	-0.4821	0.2742	0.1717
Task 7	0.1365	0.5201	0.3229	0.2127
Task 8	-0.0517	0.2137	-0.5632	-0.4136

the discrepancy between those groups on that particular factor and the tasks therein. These discrepancies are not expected to be large, for the analyses thus far have already indicated that there is little difference between the groups on individual tasks. However, exploring the relation between the two matrices may distinguish some minor areas of discrepancy buried in the data. Table 18 represents the error and transformation matrix of the low achieving group rotated against the target matrix of the control group. Table 19 shows the matrices of the reading disabled group rotated against the low achieving group, and Table 20 shows the matrices resulting from the rotation of the reading disabled group against the control group. In addition, the error matrices from Tables 18, 19 and 20 have been plotted on graphs (see Figures 3, 4 and 5) to illustrate any differences graphically. By plotting the rank-ordered points of the error matrices, it is possible to see whether or not there are any patterns arising from the transformation of one group on another. The odd-numbered tasks are syntagmatic and the even-numbered tasks are paradigmatic.

In Figure 3, the plot of the reading disabled group on the low achieving group, indicates that three of the five tasks that are most discrepant are all paradigmatic tasks. This can be seen by looking at the odd-numbered tasks (i.e., paradigmatic) on the graph. Interestingly, the comparison between the reading disabled group on the control group (Figure 4) also indicates that three of the five most discrepant tasks on that comparison are paradigmatic. In addition, Figure 5, the low achieving on control comparison, has four of the first five highest discrepancies as paradigmatic tasks. In fact, task six, with an error score of .899 is more discrepant in this comparison than any of the other tasks in any other comparisons. There appear to be indications of differences between all the groups on some of the paradigmatic measures that should be explored in order to yield further information about the language processing differences between these three groups.

One method of further exploration of the differences between the groups is to compare the Procrustes transformations of the groups rotated against one another with the two-way analysis of variance of groups and factors. Since the data had been standardized, the ANOVA yielded a non-significant group and factor difference. However, a trend was evident for a group X factor interaction (Figure 2). By comparing the Procrustes and the ANOVA data, differences in processing between the three groups may become more evident.

Table 21 illustrates the relationship between the pooled factors and the

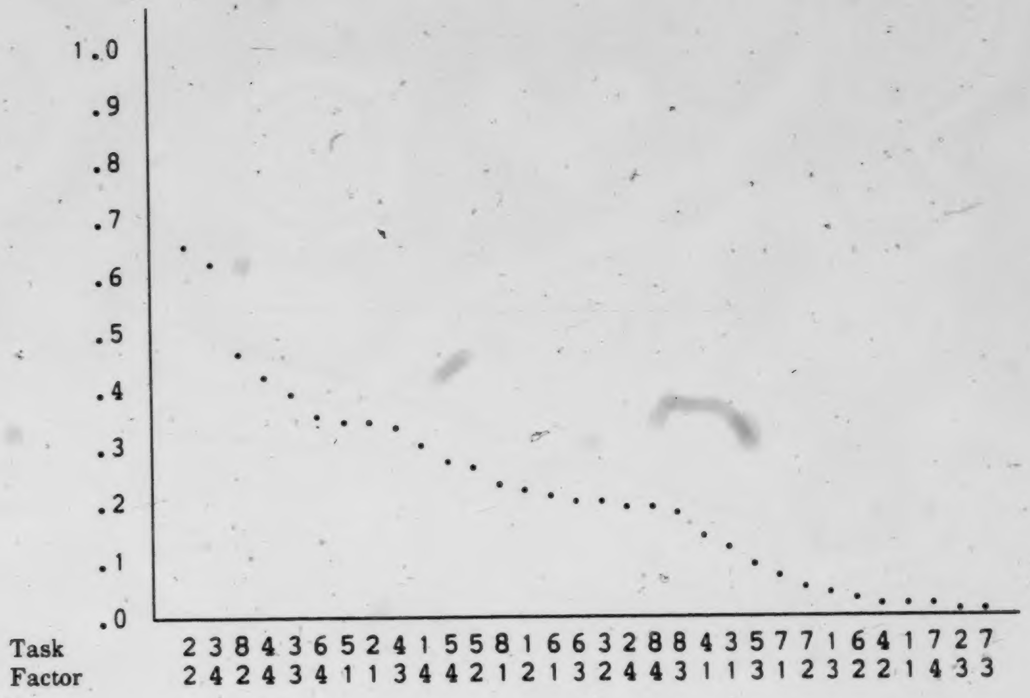

Figure 3: Graph of Procrustes Error Matrix for Reading Disabled Group on Low Achieving Group (corrected for gender)

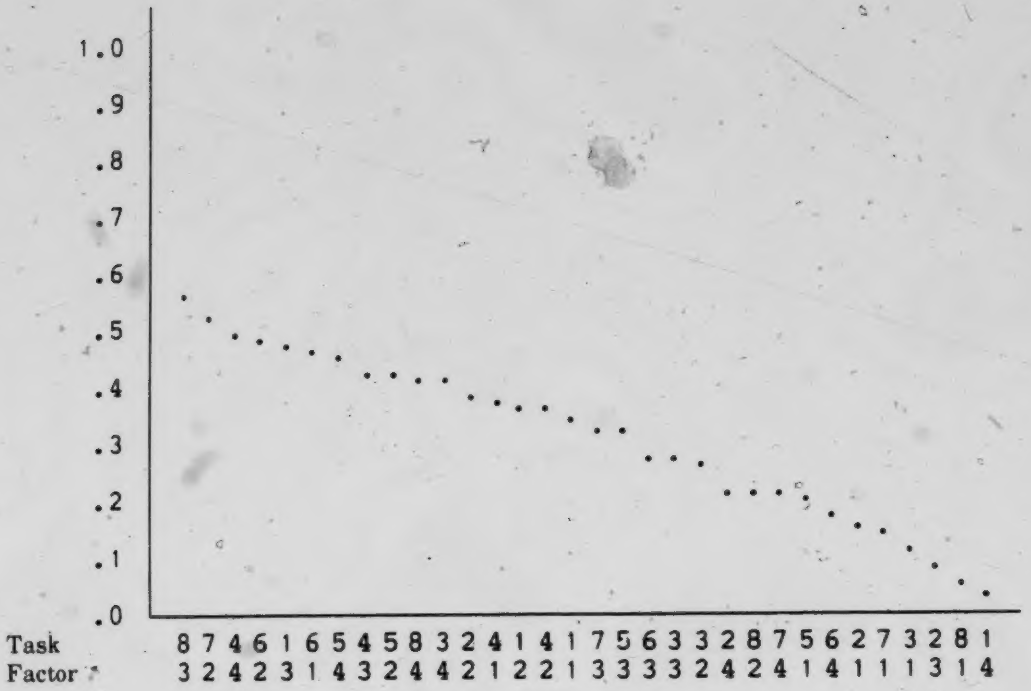

Figure 4: Graph of Procrustes Error Matrix for Reading Disabled Group on Control Group (corrected for gender)

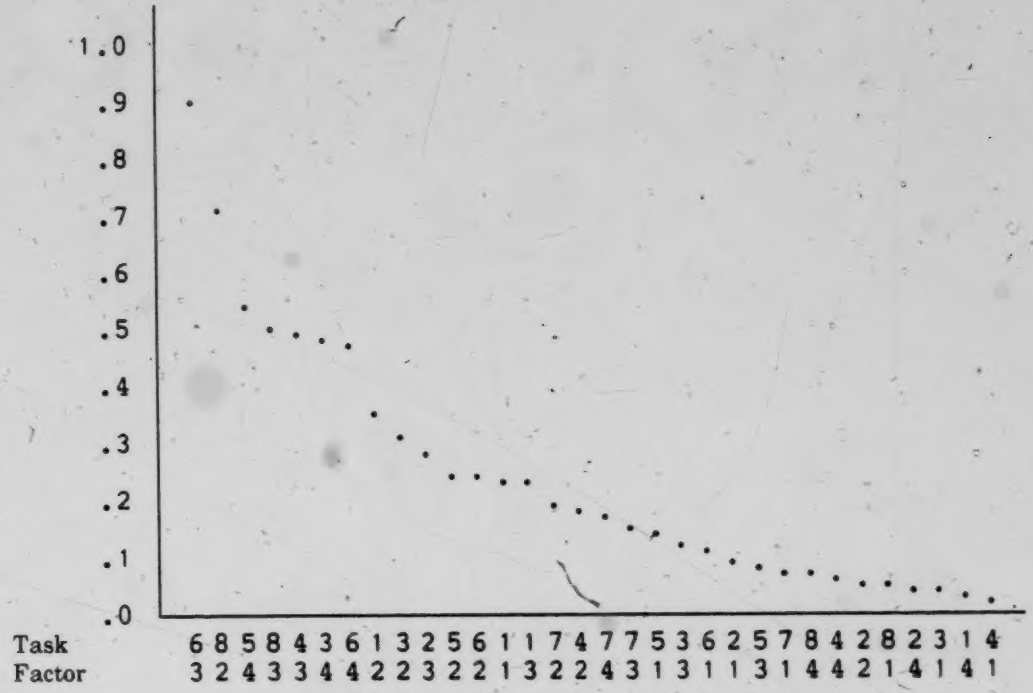

Figure 5: Graph of Procrustes Error Matrix for Low Achieving Group on Control Group (corrected for gender)

Table 21: Congruence of Pooled Matrix with Separate Subject Group Matrices[1]

Pooled	Reading Disabled	Low Achieving	Control
Factor One (Tasks -1,2,8)	Factor Two (Tasks 2,-4)	Factor One (Tasks 1,-2)	Factor One (Tasks -1,2,8)
Factor Two (Tasks -6,7)	Factor Three (Tasks 6,-7)	Factor Three (Tasks -6,7)	Factor Three (Tasks 7,-8)
Factor Three (Tasks -3,4)	Factor Four (Tasks -3,8)	Factor Two (Tasks 3,-4)	Factor Four (Tasks 4,6)
Factor Four (Task 5)	Factor One (Tasks 1,5)	Factor Four (Tasks 5,8)	Factor Two (Tasks 3,5)

[1] corrected for sex

Task 1: free word association syntagmatic
Task 2: free word association paradigmatic
Task 3: closed association syntagmatic
Task 4: closed association paradigmatic
Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 7: mediated free word association syntagmatic
Task 8: mediated free word association paradigmatic

factors which arose from the separate subject groups. It is included as clarification for Table 22. In Table 21, the pooled factors have been compared with the individual factor solutions, and the comparable solutions have been listed. In other words, the matrix of the total, pooled sample, illustrated in Table 15 has been compared to the matrices of the separate subject groups described in Table 17. By analyzing the task components of each factor, comparisons have been drawn between the pooled and separate subject matrices. In Table 22, comparisons have been made between the results of the Procrustes transformations of the separate subject groups (Tables 18, 19 & 20), and the analysis of variance carried out on the total pooled sample (Figure 2). To clarify, the factors arising from the pooled data are listed on the left-hand side of the table, along with the tasks which load on each factor. The middle section of the table illustrates the comparison of the factor matrices of the separate subject groups. As much as possible, the separate subject group factors have been compared with those pooled factors with which they appear to be most congruent (as per Table 21). The factors in parentheses indicate the factors of the target matrices (control and low achieving groups). The comparable factor is represented for the last subject group listed in each comparison, i.e., LA vs. NM would mean that the control (NM) group's factor was to be listed. The far right hand side of the table indicates the degree of error found when the separate subject factor matrices were compared via Procrustes transformation. The "Procrustes differences" listed on the table are the degrees of error found when the factor matrices of the two groups are compared. There are either two or three numbers listed, depending on the number of tasks which load on each factor. The larger the degree of error, the more variance there was between tasks.

Each of the comparisons will be considered in turn, for clarification. In other words, factor one in the pooled data is comprised of tasks one, two and eight. In the separate subject group matrices, tasks one and two loaded on factor one in the low achieving group, and tasks one, two and eight loaded on factor one in the control group. Factor one in the pooled data, therefore, is relatively comparable to factor one in the separate subject group data. When these factors are compared in the Procrustes solution, the low achieving group versus the control group yielded differences of .232 (task one), .093 (task two), and .049 (task eight). The reading disabled versus the low achieving group comparison yielded differences of .020 and .339, on tasks one and two, respectively. The differences between the reading disabled and control groups were .337, .153,

Table 22: Comparison of ANOVA Differences and Procrustes Differences[1]

Factors (Pooled Group)	ANOVA Differences (AB=.08)	Procrustes Differences		
Factor One	LA vs NM (Factor 1: -1,2,8)	.232	.093	.049
(Tasks -1,2,8)	LD vs LA (Factor 1: 1,-2)	.020	.339*	
	LD vs NM (Factor 1: -1,2,8)	.337*	.153	.052
Factor Two	LA vs NM (Factor 3: 7,-8)	.115	.498*	
(Tasks -6,7)	LD vs LA (Factor 3: -6,7)	.198	.004	
	LD vs NM (Factor 3: 7,-8)	.323*	.563*	
Factor Three	LA vs NM (Factor 4: 4,6)	.062	.473*	
(Tasks -3,4)	LD vs LA (Factor 2: 3,-4)	.197	.024	
	LD vs NM (Factor 4: 4,6)	.485*	.172	
Factor Four	LA vs NM (Factor 2: 3,5)	.307*	.244	
(Task 5)	LD vs LA (Factor 4: 5,8)	.270	.193	
	LD vs NM (Factor 2: 3,5)	.258	.420*	

[1] corrected for sex

* >.300

Task 1: free word association syntagmatic
Task 2: free word association paradigmatic
Task 3: closed association syntagmatic
Task 4: closed association paradigmatic
Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 7: mediated free word association syntagmatic
Task 8: mediated free word association paradigmatic

.052. These differences were on tasks one, two and eight. Therefore, the comparison of the Procrustes and the analysis of variance differences have yielded eight areas of difference on factor one from the pooled data. Of these eight areas, the two largest areas of difference are both found on paradigmatic tasks, i.e. tasks two (.339) and eight (.337).

Factor two in the pooled data has loadings from tasks six and seven. In the separate subject group data, tasks six and seven load on factor three in the low achieving group, and tasks seven and eight load on factor three in the control group. The three areas of greatest discrepancy (i.e. greater than .3) in this comparison involve tasks seven and eight, the syntagmatic and paradigmatic mediated free word association tasks. The paradigmatic task is discrepant in two comparisons, that between the low achieving and control groups (.498), and between the reading disabled and control groups (.563). The syntagmatic task is less discrepant, in the comparison between the reading disabled and control groups (.323).

To consider the next comparison, factor three in the pooled data is comprised of tasks three and four. However, in the group data, a comparable factor in the control group is factor four, comprised of tasks four and six. In the low achieving group, tasks three and four load together but they load on factor two. Upon examination of pooled factor three (i.e. tasks three and four), and the Procrustes results, the highest discrepancies are found in the paradigmatic tasks. The low achieving versus the control group is discrepant (.473) on task six, the paired associate paradigmatic task. In additon, the learning disabled versus the control group is discrepant (.485) on task four, the closed association paradigmatic task.

The fourth factor in the pooled data has one loading of task five. This factor is compared to factor two in the control group, with loadings of tasks three and five, and factor four in the low achieving group, with loadings of tasks five and eight. In the Procrustes comparison of reading disabled versus the control group, task five, the paired associate syntagmatic, was one of the more discrepant tasks (.420). The closed association syntagmatic task three was less discrepant (.307), in the comparision of the low achieving group with the control group.

Although all of the tasks except task one have shown some discrepancy above .3, the ones that are most discrepant among these are the paradigmatic tasks. Table 23 lists, in descending order, the five largest discrepancies illustrated in Table 22. The tasks identified as being most discrepant are tasks eight, the mediated free word association paradigmatic task and task six, the paired associate paradimatic task. Task five, the paired associate syntagmatic task also shows similar, although lessened discrepancy. It is interesting to note that, even though these are non-significant differences, the strongest differences fall within the realm of paradigmatic processing. It is also notable that these differences are observed when the reading disabled group is compared with the normal readers. The highest discrepancy on task 8 (.563), is from the comparision of the reading disabled matrix on the control matrix, as are the discrepancies of task 6 (.485) and task 5 (.420), the paired associate memory tasks. The two other comparisons are observed in the comparison between the low achieving and control groups.

Table 23: Task Discrepancies (From Table 20) in Descending Order of Magnitude

Task 8	.563
Task 8	.498
Task 6	.485
Task 6	.473
Task 5	.420

Task 5: paired association syntagmatic
Task 6: paired association paradigmatic
Task 8: mediated free word association paradigmatic

The effect of memory processes and the ability to benefit from mediation or teaching, as discussed earlier, appeared to play a large part in the way that the three subject groups were able to use their syntagmatic and paradigmatic language processes. The tasks which have been identified as being most discrepant, i.e. the mediated free word association task and the paired associate task, in this posthoc analysis are not only paradigmatic, but they are tasks which involve memory and the effect of mediation to a large degree. When studied in conjunction with the distinctive profile that the reading disabled group presents when it is compared with low achieving and normal readers, a pattern of differences begins to emerge which suggests that the reading disabled student may present a unique profile of language processing abilities.

CHAPTER VI. DISCUSSION

The purpose of this study was to explore language processing abilities in reading disabled children, low achieving readers, and children who read normally. The language processing abilities that were chosen for study were syntagmatic and paradigmatic processing.

The issues that this study attempted to explore were twofold. Firstly, word association paradigms presently used in the developmental literature were studied to assess their differential ability to produce syntagmatic and paradigmatic responses. The literature has used a variety of word association paradigms, and has related some developmental differences in their ability to produce paradigmatic and syntagmatic responses. However, in many cases, word association paradigms appear to be viewed as similar. This study attempted, instead, to view the paradigms as different, and to investigate the differences.

The second purpose of the study was to explore the differences between the three subject groups on the word association paradigms, in an attempt to further examine the language-reading disabilities relationship. In particular, the study attempted to determine if there were differences between the reading disabled group's ability to respond paradigmatically and syntagmatically, in comparison with the low achieving and the control groups. While the literature has explored the ability of children to respond to word association paradigms, few studies have specifically examined the relationship between reading disabled students and these paradigms.

A. WORD ASSOCIATION PARADIGM DIFFERENTIATION

The first question of this study addressed the similarities and differences between various word association paradigms that had been used in previous research to study syntagmatic and paradigmatic language processing. Some differentiation between paradigms has been discussed in the literature with regard to the age level at which the syntagmatic-paradigmatic shift may occur, given different paradigms (Riley and Fite, 1974). However, there has not been a comprehensive study to validate or compare the different word association paradigms to produce syntagmatic and paradigmatic language processing. In other words, for the most part, the word association paradigms have been seen as unitary, rather than unique.

Language processing is not singular in its composition, however. Memory and cognition are naturally so closely intertwined with language that the relationships between them are often indistinguishable. Language processing, therefore, has been viewed as part of the larger field of information processing (Atkinson and Shiffrin, 1968, 1971; Butler, 1984; Craik and Lockhart, 1972; Tulving, 1972). The interrelationship of language, cognition and memory has been accepted, although the understanding of the complexity of the interrelationship between these three components is in its infancy.

Theories of information processing (Atkinson and Shiffrin, 1968, 1971; Craik and Lockhart, 1972) have differed somewhat in their view of how information moves from sensory input to a permanent information base which is retrievable at will. The multi-store model (Atkinson and Shiffrin, 1968, 1971) has emphasized the actual sensory, short-term and long-term memory structures, while the level-of-processing model (Craik and Lockhart, 1972; Lockhart *et al.*, 1977) has emphasized the learner's involvement in the learning process, the context within which the learning takes place, and the semantic knowledge of the learner. The depth of the learner's processing is presumed to be affected by all of these, plus other, factors. Despite the differences in theoretical bases, however, both models have presumed the importance of memory (Mulcahy, 1980; Naus *et al.*, 1978) in the information processing system. The coding, storage and retrieval of information is presupposed in any explanation of learning. Deep processing of information is necessary to place information in the long-term memory store, while surface or shallow processing, which requires less interaction of the learner with the information, may only be sufficient to allow short-term storage, or less efficient retrieval.

Katherine Nelson's (1977) seminal article on the two specific types of language processing explored in this study has proposed that the shift from syntagmatic to paradigmatic language processing may be related to two major factors. Firstly, cognitive reorganization is presumed to allow the child better access to semantic information stored in memory. Secondly, the child becomes more able, with age, to deal with nonmeaningful verbal tasks. Nelson's primary explanation, that of cognitive reorganization, is inferred in the level-of-processing model which considers the changing ability of the child to process semantic material at deeper levels (Mulcahy, 1980; Naus *et al.*, 1978).

Before meaningful explanations of syntagmatic and paradigmatic language processing can be explored further, however, the tasks which are being used to presume this cognitive reorganization must be seen as valid measures of the two processes. Research on syntagmatic and paradigmatic language processing has primarily been carried out using word association paradigms. The paradigms in question have usually been studied singly, rather than as a group, i.e. a study would only examine syntagmatic and paradigmatic language processing within the context of one paradigm. The data which emerged from separate studies has seemingly been merged into a corporate file of syntagmatic and paradigmatic language processing. However, what remains to be done before this corporate file may be used to discuss language processing abilities of children, is to ascertain the validity of each of the separate paradigms which have been used to study paradigmatic and syntagmatic language processing. To date the research has viewed syntagmatic and paradigmatic language processing as two separate hierarchies of association (i.e., syntagmatic and paradigmatic), without exploring the possible hierarchies or levels within each of the separate types of processing.

The current study compared four major paradigms that are used in the literature to study syntagmatic and paradigmatic language processing. Free word association, closed association, paired associate and mediated free word association paradigms were studied. The data representing responses on these four word association paradigms was factor analyzed to discover the underlying processes represented. Previous research would indicate that a two factor solution was probable, since the paradigms in question had been used to study syntagmatic and paradigmatic responses (Brown & Berko, 1960; Emerson & Geloski, 1976; Entwisle, Forsyth & Muss, 1964; Ervin, 1961; McNeill, 1963, 1966). Syntagmatic tasks within the paradigms would be expected to load on the syntagmatic factor, and paradigmatic tasks would be expected to load on the paradigmatic factor.

However, in the present research, a four factor solution emerged. The uniqueness of each of the four factors is representative of the uniqueness of each of the word association paradigms, but also the complexity of language processing and the inter-relationship of language, cognition and memory.

Results of the current study indicate that there may be levels of processing inherent in both syntagmatic and paradigmatic language processing. Two paradigmatic and two syntagmatic factors emerged, each indicative of qualititative differences within each type of language processing. The factors were interpreted within an information processing model (Craik and Lockhart, 1972), which employs a level-of-processing framework. The two paradigmatic factors were illustrative of two separate levels of processing — a surface level, represented by a recognition factor, and a deeper level, represented by a long-term paradigmatic factor. The two syntagmatic factors were also defined by tasks which required different levels of processing. One of the factors was illustrative of deep processing which had resulted in long-term encoding of syntagmatic information, and the other factor was illustrative of surface, or shallow processing, resulting in short-term syntagmatic processing.

Factor one, a long-term paradigmatic factor, was illustrative of the deep processing necessary to retrieve information from long-term memory. It was composed of components from two separate paradigms, the free word aasociation and the mediated free word association paradigms. Tasks one and two, the free word association syntagmatic and paradigmatic tasks loaded together, with a negative loading of the syntagmatic task and a positive loading of the paradigmatic task. The mediated free word association paradigmatic task also loaded positively. This factor can be seen to require a certain conceptual understanding of paradigmatic relationships, both spontaneously, and after instruction. For instance, the free word association paradigm requires that the child produce a response, based on the stimulus word given by the examiner.

Similarly, the mediated paradigm requires the production of a response, but after specific instruction on paradigmatic responding. Jarman (1980) has distinguished between mnestic, perceptual and conceptual tasks. The components involved in factor one would appear to contribute to a conceptually based factor, which interfaces with memory for efficient production of paradigmatic responses.

The other paradigmatic factor to be identified was indicative of the ability to recognize, rather than produce, paradigmatic associations. Factor three was labelled paradigmatic recognition, and was comprised of both tasks of the closed association paradigm, with the syntagmatic task loading negatively and the paradigmatic task loading positively.

Since recognition is a receptive process, it would be expected to occur developmentally prior to production, an expressive process (Dale, 1976). The literature suggests that the association recognition acquisition is complete in the second grade, i.e., by age seven (Anderson and Beh, 1968). However, the ability to recognize appropriate semantic relationships does involve a link with conceptual knowledge, presumably in the long-term store. Mandler (1979) has stressed the importance of the semantic knowledge in the child's existing repetoire.

Recognition processing may require an intermediate level of processing between deep and surface processing that allows the child to match, as it were, the stimuli that are being received with their own semantic knowledge, and either confirm or reject the association. In the present study, the collaboration of both tasks from the closed association paradigm on the paradigmatic recognition factor illustrates clearly this relationship.

The two syntagmatic factors which emerged in this study are illustrative of different levels of processing. Factor two, the long-term syntagmatic factor, reinforces the complexity of the relationship between language, learning and memory. This factor, a combination of the paired associate paradigmatic and the mediated free word association syntagmatic tasks, represents syntagmatic processing of information that has been encoded, presumably at a deep level, into long-term memory. The mediational aspect of the mediated word association task infers that the mediation, or "new" learning, is integrated with semantic information and relationships in long-term memory, or "old" learning.

The inverse relationship between the two components of this factor, i.e. the paired associate paradigmatic task which loads negatively, and the mediated free word association syntagmatic task, which loads positively, illustrates the strong effect of deep processing in long-term memory. The mediated syntagmatic follows direct instruction on paradigmatic processing. The paired associate task may be regarded as a short-term memory task (Hulse *et al.*, 1975). In the context of this factor, the interaction of memory and mediation is clear. As short-term memory increases, syntagmatic responses decrease, illustrative of the effect on paradigmatic mediation.

Factor four is interesting because of its singular composition. It is made up of only one loading, that of the paired associate syntagmatic task. This factor, represented by what is clearly a memory task, may be indicative of a surface level of processing, represented in short-term memory. The paired associate paradigm is one that has been used in the verbal learning literature as a learning and a memory task. Paired-associate learning tasks have been viewed as the "most sensitive and effective tasks for assessing children's learning abilities" (Stevenson, 1972, p. 130). In the context of the developmental language literature, this paradigm has been used to measure the ability of children to learn paradigmatically and syntagmatically associated word lists. However, while viewed as a short-term task, paired associate learning has also been shown to be indicative of long-term processing (Baddeley, 1978). Children are more able to remember what is already consistent with their semantic knowledge.

This study attempted to examine the validity of each of the four paradigms on two language processing constructs, syntagmatic and paradigmatic language processing. However, the tasks used did not emerge on only two separate factors. Four factors emerged, with a mixture of syntagmatic and paradigmatic tasks in their composition. This solution has been interpreted within the information processing model. Levels of processing have been proposed as being prime factors in syntagmatic and paradigmatic processing

Within the levels-of-processing framework, memory has been found to be an essential ingredient in the langage processing paradigms studied. Memory is not an isolated process. The relation between the memory structures, control and executive processes is dynamic, and dependent on an active learner (Klein-Konisberg, 1984). Performance on short-term tasks may be dependent on the semantic knowledge previously stored in long-term memory (Baddeley, 1978). Memory is necessary, it appears, for language. Conversely, since most information is stored semantically, language may be necessary for memory. The complex interrelationship between these two major processes is only beginning to be realized. Research into memory systems (e.g., Tulving, 1985) expresses the notion that there may be multiple systems of memory, and that we may be aware of only a few. Research in syntagmatic and paradigmatic language processing has tended to focus on the shift from one process to the other, rather than on the levels of memory that may be present within each type of processing. Results of the current research have indicated that there may be levels of processing within syntagmatic and paradigmatic language processing which are influenced by, or dependent on, the interaction between learning, memory and language. However, since this study did not set out to examine these paradigms within an information-processing model, there is not necessarily direct correspondence between all of the four factors found in this study, and all of the components found in a model of information processing. Within the limitations of how syntagmatic and paradigmatic language processing was measured in this study, the information-processing framework is a cogent interpretation.

Nelson's (1977) concept of cognitive reorganization, in which information stored in memory is more accessible with age, may be seen to be a necessary component of the whole syntagmatic-paradigmatic question. Strategies and procedures for more efficient storage and retrieval of semantic information and relationships are imperative within the information processing framework. As children's language ability increases, so does their ability to learn and remember. However, there are groups of children who have difficulty with language, learning and remembering. The second question of this study explored these relationships within separate reading ability groups of children.

B. READING DISABILITY SUBJECT GROUP DIFFERENTIATION

The second question in this study dealt with the exploration of the performance and processing differences between the reading disabled group and the low achieving and normal readers on the syntagmatic and paradigmatic processing tasks.

The theoretical underpinnings of this study have related neuropsychological findings to cognitive and linguistic abilities of reading disabled children. Luria's model of neurological organization and cognitive processing (Luria, 1966b, 1973c) has been used to explore both reading and lingustic processes (Cummins & Das, 1977, 1978; Cummins & Mulcahy, 1979; Das, Kirby & Jarman, 1979; Jarman, 1980). Brain-behavior relationships have been suggested between simultanecus and successive cognitive processes and paradigmatic and syntagmatic aphasia (Luria, 1973a). Brain-behavior relationships have also been suggested between these cognitive processes and reading disabilities (Cummins & Das, 1977).

The four factors identified in the previous section as long-term paradigmatic, long-term syntagmatic, paradigmatic recognition and short-term syntagmatic have been interpreted within an information-processing model (Craik & Lockhart, 1972). The present research was not an attempt to study reading disabilities as a total information-processing package, but rather to study the relationship of reading disabilities and language processing. However, the factors which emerged for the language processing tasks related consistently within this framework, as did the interpretation of each of these factors within the reading ability groups. The factors are indicative of memory and learning processes embedded in syntagmatic and paradigmatic language processing.

Research in information processing abilities of reading disabled students has studied their performance in terms of the structural components (i.e., sensory register, short-term memory and long-term memory), the control processes (i.e., processes for encoding and retrieving information), and executive processes or strategies which allow the learners to oversee and monitor their own methods of information processing (Swanson, 1987). Reading disabilities are seen to be more than single or separate deficiencies in certain areas, but representative of "poor coordination of several mental components and/or cognitive areas involved in information processing" (Swanson, 1987, p. 159). The model used for interpretation of the four factors embodies some of each of these elements. Conversely, the factors are explained by some extent within this context.

This question of differences between the groups on each of the factors was explored by analysis of variance of the factor scores of each of the subject groups. These factor scores represented the level of processing of each group on each of the four factors. Further post-hoc exploration involved factor matching between subject groups. Both the ANOVA and the post-hoc analyses were indicative of interesting differences, particularly with regard to the reading disabled group.

The analysis to compare the performance of the different subject groups on the factor patterns did not reveal any between-group differences, as expected. There were also no within-group differences, because the data had been standardized for gender. However, the interaction of group by factor differences yielded an interesting profile. Overall, the interaction trend found by the analysis of variance indicated that the language processing was due to neither the effect of the group by itself, nor the factor by itself, but may be explained by the joint effect of both group and factor (Kerlinger, 1986).

The pattern of the interaction between groups and factors (Figure 2) is intriguing. The low achieving and control groups have shown themselves to be in direct contrast to one another, probably due to developmental differences. The reading disabled group has maintained a separate and unique profile. Overall, its performance looks more visibly uniform than either the low achieving or the control group. These processing differences may be instructive in the language-reading disabilities relationship.

Indications of differences were seen in the comparison of the reading disability group profile with the control group profile in two specific and major areas, long-term paradigmatic processing and short-term syntagmatic processing. The two factors which represented these areas were factor one, the long-term paradigmatic factor and factor four, the short-term syntagmatic factor. The post-hoc analysis also indicated some possible differences in paradigmatic processing.

Factor one, the long-term paradigmatic factor, requires both retrieval of previously learned information and a conceptual understanding of paradigmatic relationships. The factor is comprised of the syntagmatic free word association task, which loads negatively, and the free word and mediated free word association paradigmatic tasks, which load positively.

The elements present in this factor involve both learning and memory. The responses that the student makes within the context of the free word association paradigm are illustrative of the semantic associations that have been retrieved from long-term memory. Presumably, these associations, or the method of making such associations, are in the long-term memory as a result of deep processing. Similarly, the mediated free word association paradigm also requires the retrieval of information from the long-term store. However, this paradigm also functions as a learning paradigm, in that the subjects are trained in paradigmatic processing, and must integrate this training, or mediation, with their long-term store of semantic relationships. The combination of the non-mediated and mediated paradigms within this factor illustrate rather clearly the relationship between language, learning and memory.

The differences found in the long-term paradigmatic processing factor, and in paradigmatic processing as a whole, therefore, may be due to differences in one or more of the components that appear to comprise or, at least affect, paradigmatic processing. These components are memory, learning and language.

The research on memory and language is difficult to separate. Both constructs have had a primary focus in the disability literature (e.g. Mulcahy, 1980; Torgeson, 1979; Wittrock, 1986). Reading disabled students appear to have deficiencies on short-term memory tasks (Cohen, 1980; Mann, Liberman & Shankweiler, 1980; Torgeson, 1977). Strategy use for encoding and, therefore, learning new information is weak (Meichenbaum, 1976; Torgeson, 1979) in the learning disabled population. This may be due to a slow rate of developmental increase in memory strategies (Paris & Lindauer, 1977), or an inability to realize the amount of cognitive effort required to learn new information (Swanson, 1982). Ceci (1983) has suggested that learning disabled students have more difficulty comparing old and new information. Sternberg's (1987) theory has suggested that reading disabled children may be more inflexible in their thinking, and that this inflexibility may lead to deficient production of strategies for problem-solving.

The level-of-processing model implies that the amount of control applied to the material will increase both encodability and retrievability of the information. It also implies that the depth of processing choice is the responsibility of the learner. Active learners who use efficient encoding strategies may be better able to store information in long-term memory. Reading disabled students may be less able to encode and retrieve information.

The third component of paradigmatic processing is language itself. Research into the language abilities of reading disabled children would indicate that language is impaired in many areas in this population. The reading disability literature has suggested that reading disabled children have language difficulties in vocabulary (Wiig & Semel, 1980), phonological encoding (Olson *et al.*, 1985; Perfetti, 1984) and cognitive-semantic and logical processing (Vellutino, 1979). The reading disability subtype research has supported a language deficiencies approach to the reading disabilities question as well (Fisk & Rourke, 1979; Lyon, 1982; Satz & Morris, 1981). Research with learning disabled students, as well as poor readers, has indicated that reading ability is directly related to paradigmatic processing. Shen and McNinch (1971) found a significant difference in the frequency of paradigmatic responses of good and poor eighth grade readers. Similarly, Dinnan, Bickley and Williams (1971) found a direct relationship between paradigmatic responses and reading. Bateman (1963) reported that high paradigmatic performance on word association tasks predicted high level reading ability.

Performance in paradigmatic language processing may also be related to cognitive processing. Neuropsychological theory (Luria, 1973a) has suggested that paradigmatic language processing occurs at a similar site to simultaneous processing. Reading disabled students' performance on a paradigmatic processing factor in this research may, therefore, be related both to less efficient paradigmatic processing and less efficient simultaneous processing. These results would coincide with Vellutino's concept of congitive-linguistic (1979) theory, which reinforces the importance of language in the reading process. Cummins and Das (1977) have suggested that simultaneous processing is more important in advanced stages of reading, after decoding skills have been learned. The less efficient performance of grade four reading disabled students on a paradigmatic language processing factor may relate to underlying difficulties with simultaneous processing.

The second area of possible differentiation found in this study was the short-term syntagmatic factor, factor four. The paired associate syntagmatic task was the singular positive loading on this factor. This task is primarily a memory task, involving surface processing of a list of syntagmatic word pairs. However, as indicated earlier, the paired associate task may also be seen to be indicative of long-term processing (Baddeley, 1978). Children who have encoded word pairs on a syntagmatic basis are more likely to have the semantic organization required for retrievel than those who have used other methods of processing.

The interaction of memory, language and learning may be equally important for an explanation of the reading disabled group's difference on short-term syntagmatic processing as it was for paradigmatic processing. However, the short-term syntagmatic factor employed on factor four may also be indicative of successive cognitive processing. Luria's (1973a) neuropsychological model suggests that syntagmatic and successive processes may occur in similar sites. Research with reading disabled children has shown them to be less proficient on phonological coding, which is believed to rely heavily on successive processing, than normal readers (Gough & Hillinger, 1980; Liberman, 1982; Stanovich, 1985). Cummins and Das (1977) have reported that successive processing is necessary for early reading (i.e., decoding skills) to develop, and concur that reading disabled students may be deficient in this process. Inadequate successive processing, however, may also be related to lack of strategies for remembering (e.g., Torgeson, 1979). Research with reading disabled students has shown that they exhibit less efficient strategies for encoding or retrieving information (Ceci, 1983: Torgeson, 1979).

The short-term syntagmatic processing factor would require the student to use some strategies for remembering word pairs for a short period of time. The results indicate that this group of reading disabled students may have been less efficient at spontaneous use of strategies for encoding this information.

However, the present research has indicated one area where the reading disabled group did not differ from the normal achieving group. Similar performance was exhibited on factor two, the long-term syntagmatic factor. Factor two was comprised of two components, the paradigmatic paired associate task six, and the syntagmatic mediated free word association task seven. The paired associate task required, at least, short term memory processing of a list of paradigmatically organized word pairs (Jarman, 1980). The mediated free word association syntagmatic task requird the student to respond to a stimulus word, after receiving instructions on paradigmatic responding. The paradigmatic task loaded negatively, and the syntagmatic task loaded positively, suggesting an inverse relationship, i.e., as memory for paradigmatic word pairs increases, syntagmatic responding to a free response task decreases. Conversely, as memory for paradigmatic word pairs decreases, syntagmatic responses increase.

The mediational/memory aspect of factor two is extremely important in the discussion of reading disabilies. The results of this study indicate, like Feuerstein (1980) and Vygotsky (1963), that mediation does enhance the performance of poorer learners, at least on the language processing tasks studied. On this factor, the reading disabled students performed at the same level as their normal reading peers. This may not seem surprising or enlightening, except when factor two is considered in the light of factors one and four. On these factors, the reading disabled students displayed a somewhat lower level of performance than normal readers on both paradigmatic processing and short-term memory tasks.

The low achieving students, on the other hand, whose performance on both factors one and four had been lower than that of the reading disabled group, showed the opposite pattern. That is, their performance indicated a higher level of syntagmatic processing than either the reading disabled or low achieving readers. This performance clearly indicates the interaction of mediation, memory and long-term storage. The students would be expected to respond in a less syntagmatic manner, as they had just experienced instruction on paradigmatic processing. However, the inverse relationship between the memory and mediational components of this factor may be an indication that the low achieving readers responded more syntagmatically than their normal reading or reading disabled peers.

The low achieving group's performance on this factor indicates that syntagmatic processing may be stored at a deeper level, and may be immobile with respect to mediation. This performance clearly adds credence to those who stress the importance of the existing memory store for learning new information (Baddeley, 1978).

Although research into memory and mediational strategies has become quite extensive, especially within the reading disabled population, there is little research which examines the relationship between these two processes. The present research indicates that, in certain instances, the relationship between mediation and memory may reflect individual differences. For the reading disabled youngsters in this study, mediation may have had a positive effect on learning, and may, indeed, have counteracted the effect of a less proficient memory.

Factor three has not been addressed yet in this discussion. This factor, comprised of the closed association syntagmatic and paradigmatic tasks did not appear to demonstrate results which are interpretable within the present literature on language and information processing. It was defined as a paradigmatic factor, which required the recognition of paradigmatic responses. From the results of the long-term paradigmatic factor, a similar pattern would be expected to evolve. On factor one, for instance, the high performance of the control group and the low performance of the low achieving group were almost in direct contrast to one another. The reading disabled group performed at a level between the two groups. On factor three, however, the low achieving group performance was highest, followed by the reading disabled and the control group.

Indeed, the relationship between the three groups on this factor was almost inverse to the performance on factor one. The inversion of the results of the recognition and production paradigms (i.e., closed association and free word association) is indicative of subject interpretation of task requirements. The phrase "go better with" in the task question "Does (stimulus word) go better with (stimulus word) or (stimulus word)?" may have been the cause of this interpretation.

Both the reading disabled and control groups chose to respond syntagmatically more than paradigmatically. The profile that is seen of factor three comparisons between the three groups is interesting, because the groups appear to be using different processes. The low achieving group appear to be using a paradigmatic process, i.e. choosing the paradigmatic response offered. The control group, on the other hand, appear to be using more of a syntagmatic process in the same paradigm. By choosing the response that "sounds right", and is similar to everyday language use, they are choosing the syntagmatic responses.

The low achieving group, on the other hand, may be using a different strategy, that of picking opposites and similarities, for example. The learning disabled group, on the other hand, are again very close to the mean, and performing between the two other groups. This may indicate that they are using some of both processes, and have not yet internalized either processing scheme. Since others (Anderson and Beh, 1968; Ervin, 1961; Riley and Fite, 1974) have shown that the syntagmatic-paradigmatic shift in associative recognition acquistion is complete sometime within the second and third grades, this difference in processing is not expected, and cannot be explained by the present literature. More research will certainly be needed in this area to more completely analyze processing differences between subject groups on this particular paradigm.

Reading disabled students have been differentiated, at least to a minor degree, from other poor readers, and from normal readers, on two separate processes. The first of these is the paradigmatic processing factor. The reading disabled students appear to process paradigmatic information somewhat less efficiently than normal readers. This would concur with the small amount of literature which examines the relationship between reading ability and paradigmatic processing. It is also possible, however, that lowered paradigmatic processing may be indicative of a lessened level of simultaneous processing in the reading disabled group.

The results of this study also add specific information about the types of paradigmatic processing tasks that are most discriminating between subject groups. The free word association paradigm appears to be one paradigm which was most useful in discerning the long-term paradigmatic processing abilities of groups of students in this study. Memory, as examined on a syntagmatic short-term factor, is the other process where some group differentiation has been indicated. The interesting information gained by this study, however, indicates that mediation may be able to interact to allow the development of more efficient memory strategies in reading disabled students. Indeed, mediation in the present study allowed the reading disabled students to process information as efficiently as their non-disabled peers.

Paradigm diversity was a major question of this study. Clearly, the word association paradigms that have been used in the literature to assess syntagmatic and paradigmatic language processing are unique. This uniqueness must be taken into account when measures of language processing are being assessed. More importantly, however, this study has indicated that there are differences within syntagmatic and paradigmatic processes. To date, studies have explored syntagmatic and paradigmatic processing within a two-process model. This study viewed syntagmatic and paradigmatic processing within a theoretical framework of learning and memory. Within this framework, it is clear that there are different levels or types of syntagmatic and paradigmatic processing which must be explored further, within normal and exceptional populations, and within different paradigms.

This study has outlined four of the major paradigms used in the literature, has indicated levels of processes which appear to be most predominant in each of the paradigms, and has discussed the differences exhibited by reading disabled subjects. Psychologists, speech-language clinicians and all others interested in assessing language abilities of exceptional learners must be cognizant of levels of processing within these paradigms.

C. LIMITATIONS OF THE STUDY

1. Restriction of Range

Because of the ability group classification system used in this study, the range of IQ and achievement was explicitly restricted. The correlation of these independent variables with the specific language processing tasks used in the study leads to an implicit restriction of range on the dependent measures, as discussed. Although the classification system used was necessary for the purposes of the study, the effect of this restriction of range cannot be minimized. The correlation matrices of the dependent variables are probably smaller as a result. Consequently, the factor matrices produced from these correlation matrices may be somewhat modified from what they would have been in the overall population.

2. Scales

Because each of the paradigms was divided into syntagmatic and paradigmatic responses, the maximum score on each task (with the exception of the paired association paradigm) was ten. This small number of responses may not be enough to allow differences between the groups to emerge. Other studies should lengthen the number of stimuli to allow more chances for both syntagmatic and paradigmatic responses to occur and therefore allow any hidden differences between groups to emerge.

D. SUGGESTIONS FOR FUTURE RESEARCH

This study has interpreted the four factors within an information-processing framework of learning and memory. The results have clearly indicated the importance of viewing language within such a model. However, since the study was designed to compare language processing paradigms and group performance on these paradigms, the results do not correspond to the information-processing model in an isomorphic fashion. Future research to examine different language processing systems within the whole structure of information processing may produce more evidence about the interaction of learning, memory and language presented here. For instance, research to fully investigate the memory components of word association paradigms would add needed information about the underlying processes that affect the paradigms. In addition, using a diversity of word association paradigms would allow future researchers to examine even more or different levels of processing within the paradigms.

The study did not set out to study mediational strategies, but the results clearly illustrated that mediation is an important component of selected word association paradigms. This needs to be explored further, particularly with reading disabled students, who were shown in this research to benefit from the mediation. Much of the research in strategy training has been in the area of metacognition, memory and reading (e.g., Brown, 1977; Brown & Palinscar, 1982; Flavell, 1970; Reeve & Brown, 1985; Weaver, 1979). Results of this study would indicate that interested researchers may move into the area of strategy training in language processing tsks, with the ultimate aim of connecting more strategic memory and language use to better overall learning strategies.

Lastly, but perhaps most importantly, the reading disabled groups has been shown by this study to have some possible differences in paradigmatic processing. However, because of the nature of this empirical study, individuals or small groups of reading disabled students were not studied separately from the large subject group. Further research in this area may do well to investigate subgroups of reading disabled students in a process-oriented framework to further enhance our knowledge of the language-reading disabilities relationship.

REFERENCES

Anderson, J. R. & Beh, W. (1968). The reorganization of verbal memory in childhood. Journal of Verbal Learning and Verbal Behavior, 7, 1049-1053.

Anderson, J. R. & Bower, G. H. (1973). Human association memory. New York: V. H. Winston and Sons.

Aram, D. M. & Nation, J. E. (1975). Patterns of language behavior in children with developmental language disorders. Journal of Speech and Hearing Research, 18, 229-241.

Aram, D. M. & Nation, J. E. (1980). Preschool language disorders and subsequent language and academic difficulties. Journal of Communication Disorders, 13, 159-170.

Asarnow, J. R. & Meichenbaum, D. (1979). Verbal rehearsal and serial recall: The mediational training of kindergarten children. Child Development, 50, 1173-1177.

Atkinson, R. D. & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence and J. T. Spence (Ed.). The Psychology of Learning and Motivation, Vol. 2.

Atkinson, R. & Shiffrin, R. (1971). The control of short-term memory. Scientific American, 225, 82-90.

Baddeley, A. D. (1978). The trouble with levels: A re-examination of Craik and Lochhart's framework for memory research. Psychological Review, 85, 139-152.

Baker, L. & Brown, A. L. (1984). Metacognitive skills in reading. In P. D. Pearson (Ed.), Handbook of Reading Research (pp. 353-394). New York: Longman.

Bartel, N., Grill, J., Bartel, H. (1973). The syntagmatic-paradigmatic shift in learning disabled and normal children. Journal of Learning Disabilities, 6, 518-523.

Bateman, B. D. (1966). Learning disorders: Education of exceptional children. Journal of Learning Disabilities, 6, 59-64.

Bates, E. & Macwhinney, E. (1984). Cue validity and sentence interpretation in English, German & Italian. Journal of Learning and Verbal Behavior, 23, 127-150.

Bauer, R. H. (1979). Memory, acquistion, and category clustering in learning-disabled children. Journal of Experimental Child Psychology, 27, 365-383.

Bauer, R. H. (1977). Memory processes in children with learning disabilities. Journal of Experimental Child Psychology, 24, 415-430.

Benton, A. L. (1962). Dyslexia in relation to form perception and directional sense. In J. Money (Ed.), Reading disability: Progress and research needs in dyslexia (pp. 81-102). Baltimore: John Hopkins Press.

Berk, R. A. (1984). Screening and diagnosis of children with learning disabilities. Springfield, Il: Charles C. Thomas.

Bilodeau, E. A. & Howell, D. C. (1965). Free association norms by discrete and continued methods. Washington, DC: Office of Naval Research.

Blackman, L. S., Bilsky, L. H., Burger, A. L. & Mar, H. (1976). Cognitive processes and academic achievement in EMR adolescents. American Journal of Mental Deficiency, 81, 125-134.

Blackman, L. S. & Burger, A. L. (1972) Psychological factors related to early reading behavior of EMR and nonretarded children. American Journal of Mental Deficiency, 77, 212-229.

Blank, M. (1978). Review of "Toward an understanding of dyslexia: psychological factors in specific reading disability." In A. L. Benton and D. Pearl (Eds.), Dyslexia: An Appraisal of Current Research. New York: Oxford University Press, pp. 113-122.

Bloom, L. & Lahey, M. (1978). Language development and language disorders. New York: John Wiley and Sons.

Boder, E. (1971a). Developmental dyslexia: A new diagnostic approach based on the identification of the subtypes. Journal of School Health, 40, 287-290.

Boder, E. (1971b). Developmental dyslexia: Prevailing concepts and a new diagnostic approach. In H. Myklebust (Ed.), Progress in Learning Disability Vol. II (pp. 293-321). New York: Grune and Stratton.

Boder, E. (1973). Developmental dyslexia: A diagnostic approach based on three atypical reading patterns. Developmental Medicine and Child Neurology, 15, 663-687.

Brown, A. L. (1980). Metacognitive development and reading. In R. J. Spiro, B. Bruce, & W. F. Brewer (Eds.), Theoretical issues in reading comprehension (pp. 453-482). Hillsdale, NJ: Erlbaum Associates; 453-482.

Brown, R. (1973). The early stages. Cambridge: Harvard University Press.

Brown, R. & Berko, J. (1960). Word association of the acquisition of grammar. Child Development, 31, 1-14.

Bruner, J. (1984). Language interaction & self-talk. Journal of American Academy of Child Psychiatry, 23, 1-7.

Bryan, T. H. (1978). Social relationships and verbal interactions of learning disabled children. Journal of Learning Disabilities, 11, 107-115.

Carmon, A., Nachson, I. & Starinsky, R. (1976). Developmental aspects of visual hemifield differences in perception of verbal material. Brain Language, 3. 463-469.

Carrow-Woolfolk, E. & Lynch, J. I. (1982). An integrative approach to language disorders in children. New York: Grune & Stratton.

Cattell, R. B. (1966). The scree test for the number of factors. Multivariate Behavioral Research, 1, 245-276.

Ceci, S. J. (1983). Automatic and purposive semantic processing characteristics of normal and language/learning disabled children. Development Psychology, 19, 427-439.

Chipman, S., Siegel, J. & Glaser R. (Eds.). (1984). Thinking and Learning Skills: Current Research and Open Questions, (Vols. 1 & 2). Hillsdale, NJ: Erlbaum Associates.

Christensen, S., Ysseldyke, J. E. & Algozzine, B. (1982). Institutional and external pressures influencing referral decisions. Psychology in the Schools, 19, 341-345.

Chomsky, N. (1957). Syntactic structures. The Hague: Mouton.

Chomsky, N. (1965). Aspects of the theory of syntex. Cambridge: MIT Press.

Clark, H. H. (1970). Word associations and linguistic theory. In J. Lyons (Eds.), New Horizons in Linguistics. Harmondsworth, Middlesex, England: Penguin Books.

Connors, C. K. (1970). Cortical visual evoked response in children with learning disorders. Psychophysiology, 7, 418-428.

Craig, P. A., Kasowitz, D. H. & Malgoire, M. A. (1978). Teacher identification of handicapped pupils (ages six to eleven) compared with identifications using other indicators (Research Report EPRC 4537-11). Mento Park, CA: Stanford Research Institute.

Craik, F. I. M. & Lockhart, R. S. (1972). Levels of processing: a framework for memory research. Journal of Verbal Learning and Verbal Behavior, 11, 671-682.

Cramer, P. (1974). Idiodynamic sets as determinants of children's false recognition errors. Developmental Psychology, 10, 86-92.

Critchley, M. (1970). The dyslexic child. Springfield, Il: Charles C. Thomas.

Cruickshank, W. M., Bentzen, F., Ratzeburg, F. & Tannhauser, M. (1961). A teaching method for brain-injured and hyperactive children. Syracuse, NY: Syracuse University Press

Cummins, J. (1973). Systems of mediation in memory and reasoning. Paper presented to the annual conference of the Canadian Psychological Association, BC: Victoria.

Cummins, J. & Das, J. P. (1977). Cognitive processing and reading difficulties: A framework for research. Alberta Journal of Educational Research, 23, 245-256.

Cummins, J. & Das, J. P. (1978). Simultaneous and successive syntheses and linguistic processes. International Journal of Psychology, 13, 129-138.

Cummins, J. & Mulcahy, R. (1979). Simultaneous and successive processing and narrative speech. Canadian Journal of Behavioral Science, 11, 64-71.

Dale, P. S. (1976). Language Development, (2nd ed.). New York: Holt, Rinehart and Winston.

Dallago, M. L. L. & Moely, B. E. (1980). Free recall in boys of normal and poor reading levels as a function of task manipulations. Journal of Experimental Child Psychology, 30, 62-78.

Das, J. P., Cummins, J., Kirby, J. & Jarman, R. F. (1979). Simultaneous and successive processing language and mental abilities. Canadian Psychology Review, 20, 1-11.

Das, J. P. & Hawkeye, L. (1979). Measures of simultaneous successive and planning processes. Unpublished manuscript. University of Alberta, Center for Study of Mental Retardation, Edmonton.

Das, J. P., Kirby, J. & Jarman, R. F. (1975). Simultaneous and successive syntheses: An alternative model for cognitive abilities. Psychological Bulletin, 82, 87-103.

Das, J. P. Mulcahy, R. F. & Wall, A. E. (1982). Theory and research in learning disabilities. New York: Plenum Press.

Davidson, R. E. (1964). Mediation and ability in paired-associate learning. Journal of Educational Psychology, 55, 352-356.

Deese, J. (1965). The structure of associations in language and thought. Baltimore: Johns Hopkins Press.

Denckla, M. B. (1979). Childhood learning disabilities. In K. M. Heilman & E. Valenstein (Eds.), Clinical Neuropsychology, New York: Oxford University Press.

Denckla, M. B. (1983). The neuropsychology of socio-emotional learning disabilities. Archives in Neurology, 40, 461-462.

Denckla, M. B. & Rudel, R. G. (1974). Rapid "automatized" naming of pictured objects, colors, letters and numbers by normal children. Cortex, 10, 186-202.

Denckla, M. B. (1977a). Minimal brain dysfunction and dyslexia: Beyond diagnosis by exclusion. In M. E. Blaw, I. Rapin & M. Kinsbourne (Eds.), Topics in child neurology. New York: Spectrum Publications.

Denckla, M. B. (1977b). The neurological basis of reading disability. In F. G. Roswell & G. Natchez (Eds.), Reading disability: A human approach to learning (pp. 25-47). New York: Basic Books.

Denney, N. W. & Ziobrowski, M. (1972). Developmental changes in clustering criteria. Journal of Experimental Child Psychology, 13, 275-282.

DeRuiter, J. A. & Wansart, W. L. (1982). Psychology of learning disabilities: Applications and educational practice. Rockville, MD: Aspen Systems Corp.

Haggarty, R. & Stamm, J. (1978). Dichotic auditory fusion levels in children with learning disabilities. Neuropsychologia, 16, 349-368.

Dinnau, J., Bickley, R. & Williams, J. (1971). Syntagmatic oral responses compared with high and low verbal SAT scores of college freshmen. Twentieth Yearbook of National Reading Conference, 17-19.

Doehring, D. G. (1968). Patterns of impairment in specific reading disability. Bloomington, Ind.: Indiana University Park Press.

Doehring, D. G. (1976). Two models of reading disability. In R. M. Knights & D. J. Bakker (Eds.), The neuropsychology of learning disorders: Theoretical approaches. Baltimore: University Park Press.

Doehring, D. G. (1978). The tangled web of behavioral research on developmental dyslexia. In A. L. Benton & D. Pearl (Eds.), Dyslexia: An appraisal of current knowledge. New York: Oxford University Press.

Doehring, D. G., Trites, R. L. & Patel, P. G. (1981). Neuropsychological and linguistic correlates of 3 types of reading-disabilities. International Journal of Neuroscience, 12, 108-113.

Doyle, R. B., Anderson, R. P. & Halcomb, C. G. (1976). Attention deficits and the effects of visual distraction. Journal of Learning Disabilities, 9, 48-54.

Downing, J., Ayers, D. & Schaefer, B. (1978). Conceptual & perceptual factors in learning to read. Educational Research, 21, 11-17.

Downing, J. & Leong, C. K. (1982). Psychology of reading. New York: MacMillan Publishing Company, Inc.

Drake, W. (1968). Clinical and pathological findings in a child with a developmental learning disability. Journal of Learning Disabilities, 1, 468-475.

Duane, D. D. & Rawson, M. E. (Eds.). (1974). Reading, perception and language. Baltimore: York Press.

Duchan, J. (1986). Learning to describe events. Special issue: Semantic factors in language developmental disorders. Topics in Language Disorders, 6, 27-36.

Ellis, A. W. (1981). Developmental and acquired dyslexia: Some observation on Jorm (1979). Cognition, 15.

Ellis, N. C. (1980). Functional analysis of reading and short-term memory in dyslexic children. Doctoral dissertation, University of Wales, Cardiff.

Ellis, N. C. & Miles, T. R. (1981). A lexical encoding deficiency 1: Experimental evidence. In G. Th. Pavlidis & T. R. Miles (Eds.), Dyslexia research and its applications to education. London: J. Wiley and Sons.

Emerson, H. F. and Gekoski, W. L. (1976). Interactive and categorical grouping strategies and the syntagmatic-paradigmatic shift. Child Development, 47, 1116-1121.

Entwisle, D. R. & Forsyth, D. F. (1963). Word associations of children: Effect of method of administration. Psychological Reports, 13, 291-299.

Entwisle, D. R., Forsyth, D. F. & Muuss, R. (1964). The syntagmatic-paradigmatic shift in children's word associations. Journal of Verbal Learning and Verbal Behavior, 3, 19-29.

Entwisle, D. R. (1966). The word associations of young children. Baltimore: Johns Hopkins University Press.

Ervin, S. M. (1957, September). Grammar and classification. Paper read at the meeting of the American Psychological Association, New York.

Ervin, S. M. (1961). Changes with age in the verbal determinants of word association. American Journal of Psychology, 74, 361-372. Federal Register, Washington, DC (Thursday, 29, December 1977), 65082-65085.

Ferguson, G. A. (1981). Statistical analysis in psychology and eduction (5th ed.). New York: McGraw-Hill.

Feuerstein, R. (1980). Instrumental enrichment: An intervention program for cognitive modifiability. Baltimore: University Park Press.

Fisk, I. L. & Rourke, B. P. (1979). Identification of learning disabled children at three age levels: A neuropsychological, multivariate approach. Journal of Clinical Neuropsychology, 1, 289-310.

Fletcher, J. M. (1981). Linguistic factors in reading acquisition - evidence for developmental - changes. In F. J. Pirozzolo & M. C. Wittrock, (Eds.). Neuropsychological and cognitive processes in reading. New York: Academic Press.

Forsyth, D. F. (1963). Word associations of children: The effect of the method of administration. Psychological Reports, 13, 291-299.

Francis, H. (1972). Toward an explanation of the syntagmatic-paradigmatic shift. Child Development, 43, 942-958.

Freston, C. W. & Drew, C. J. (1974). Verbal performance of learning disabled children as a function of input organization. Journal of Learning Disabilities, 7, 34-38.

Frith, U. (1981) Experimental approaches to developmental dyslexia: An introduction. Psychological Research, 43, 97-109.

Frostig, M. (1961). Developmental test of visual perception (3rd ed.). Palo Alto, California: Consulting Psychology Press.

Galabura, A. M. & Kemper, T. (1979). Cytoarchitectonic abnormalities in developmental dyslexia: A case study. Annals of Neurology, 6, 94-100.

Gallagher, T. M. & Prutting, C. A. (1983). Pragmatic assessment intervention issues in language. San Diego: College-Hill Press, Inc.

Gerber, A. & Bryen, E. (1981). Language and learning disabilities. Baltimore, University Park Press.

Geschwind, N. (1970). The organization of language and the brain. Science, 170, 940-944.

Gibson, E. J. & Levin, H. (1975). The psychology of reading. Cambridge: MIT Press.

Golin Koff, R. M. (1981). The case for semantic relations - evidence from the verbal & nonverbal domains. Journal of Child Language, 8, 413-437.

Goodman, K. (1969). Analysis of oral reading miscues: Applied psycholinguistics. Reading Research Quarterly, 4, 9-30.

Guthrie, J. T. (1973). Reading comprehension and syntactic responses in good and poor readers. Journal of Educational Psychology, 65, 294-299.

Haggarty, R. & Stamm, J. (1978). Dichotic auditory fusion levels in children with learning disabilities. Neuropsychologia, 16, 349-368.

Hakes, D. T. (1980). The development of metalinguistic abilities in children. New York: Sringer-Venlag.

Hallahan, D. P. (1975a). Comparative research studies on the psychological character of learning disabled children. In W. M. Cruickshank & D. P. Hallahan (Eds.), Perceptual and learning disabilities in children. Vol 1. Psychoeducational practices (pp. 29-60). Syracuse, NY: Syracuse University Press.

Hallahan, D. P. (1975b). Distractibility in learning disabled children. In W. M. Cruickshank & D. P. Hallahan (Eds.), Preceptual and learning disabilities in children. Vol 2. Psychoeducational practices (pp. 195-218). Syracuse, NY: Syracuse University Press.

Hallahan, D. P. & Kauffman, J. M. (1976). Introduction to learning disabilities. Englewood Cliffs, N.J.: Prentice Hall.

Halliday, M. A. K. (1975). Learning how to mean: Explorations in the development of language. London: Arnold.

Hall, J. W. & Halperin, M. S. (1972). The development of memory-encoding processes in young children. Developmental Psychology, 6, 181.

Hammill, D., Leigh, J., McNutt, G. & Larsen, S. (1981). A new definition of learning disabilities. Learning Disability Quarterly, 4, 336-342.

Hanley, J. & Sklar, B. (1976). Electroencephalic correlates of developmental reading dyslexics: Computer analysis of recordings from normal and dyslexic children. In G. Leisman (Ed.), Basic visual process and learning disability (pp. 212-243). Springfield, Il: Charles C. Thomas.

Harris, P. (1975). Children's comprehension of complex sentences. Journal of Experimental Child Psychology, 19, 420-433.

Harris, P. (1975). Inferences and semantic development. *Journal of Child Language*, *2*, 143-152.

Hier, D. B. (1979). Sex differences in hemispheric specialization: Hypothesis for the excess of dyslexia in boys. *Orton Society Bulletin*, *29*, 74-83.

Hier, D. B., Le May, M., Rosenberger, P. B. & Perlo, V. P. (1978). Developmental dyslexia. Evidence for a subgroup with a reversal of cerebral asymmetry. *Archives of Neurology*, *35*, 90-92.

Hinshelwood, J. (1917). *Congenital word blindness*. London: H. K. Lewis.

Hook, P. (1976). *A study of metalinguistic awareness and reading strategies in proficient and learning disabled readers*. Unpublished doctoral dissertation, Northwestern University.

Houck, C. (1984). *Learning disabilities: Understanding concepts, characteristics and issues*. Englewood Cliffs, NJ: Prentice Hall.

Horn, W. F. & O'Donnell, J. P. (1984). Early identification of learning disabilities: A comparison of two methods. *Journal of Educational Psychology*, *76*, 1106-1118.

Ingram, T. T. S., Mason, A. W. & Blackburn, I. (1970). A retrospective study of 82 children with reading disability. *Developmental Medicine and Child Neurology*, *40*, 1-23.

Jakobson, R. (1971). *Studies on child language and aphasia*. The Hague: Mouton.

Jansky, J. & de Hirsh, K. (1973). *Preventing reading failure*. New York: Harper and Row.

Jarman, R. F. (1978). Patterns of cognitive ability in retarded children: A re-exam. *American Journal of Mental Deficiency*, *82*, 344-348.

Jarman, R. F. (1980). Cognitive processes and syntactical structure: Analysis of paradigmatic and syntagmatic associations. *Psychological Research*, *41*, 153-167.

Jarman, R. F. & Das J. P. (1977). Simultaneous and successive syntheses and intelligence. *Intelligence*, *1*, 127-150.

Jenkins, J. J. & Russell, W. A. (1960). Systematic changes in word association norms: 1910-1952. *Journal of Abnormal Social Psychology*, *60*, 293-304.

Jensen, A. R. (1969). How much can we boost IQ and scholastic achievement? *Harvard Education Review*, *39*, 1-123.

Johnson, D. J. & Myklebust, H. R. (1967). *Learning disabilities: Educational principles and practices*. New York: Grune and Stratton.

Joner, F. M. (Eds.). (1980). *Language disability in children: Assessment and remeditation*. Baltimore: University Park Press.

Jorm, A. F. (1979). The cognitive and neurological basis of developmental dyslexia: A theoretical framework and review. *Cognition*, *7*, 19-33.

Jung, C. G. (1918). *Studies in word association*. London: William Heinemann (Medical Books) Ltd.

Katz, J. J. & Fodor, J. A. (1963). The structure of a semantic theory. *Language*, *39*, 170-210.

Kaufman, D. & Kaufman, P. (1979). Strategy training and remedial techniques. *Journal of Learning Disabilities*, *12*, 416-419.

Kavale, K., Alper, A. & Purcell, L. (1981). Behavior disorders and teacher perceptions. *The Exceptional Child*, *28*, 114-118.

Kavale, K. & Forness, S. R. (1985). *The science of learning disabilities*. San Diego: College Hill Press.

Kephart, N. (1960). *The slow learner in the classroom*. Columbus, Ohio: Charles E. Merrill.

Kerlinger, F. N. (1973). *Foundations of behavioral research* (2nd ed.). New York: Holt, Rinehart and Winston, Inc.

Kinsbourne, M. & Caplan, P. (1979). *Children's learning and attention problems*. Boston: Little Brown & Co.

Kinsbourne, M. & Warrington, E. K. (1966). Developmental factors in reading and writing backwardness. In J. Money (Ed.), *The disabled reader*. Baltimore: The Johns Hopkins Press.

Kirby, J. R. & Das, J. P. (1976). Comments on Paivio's imagery theory. *Canadian Psychological Review*, *17*, 66-68.

Kirby, J. R. & Das, J. P. (1977). Reading achievement, IQ and simultaneous successive processing. *Journal of Educational Psychology*, *67*, 564-570.

Kirk, S. A. (1963). *A behavioral diagnosis and remediation of learning disabilities*. Proceedings of the Conference on Exploration into the Problems of the Perceptually Handicapped Child, *1*.

Kirk, U. (Ed.). (1983). *Neuropsychology of language, reading and spelling*. New York: Academic Press.

Knights, R. M. & Bakker, D. J. (Eds.). (1975). The neuropsychology of learning disorders: Theoretical approaches. Baltimore: University Park Press.

Krupski, A. (1980). Attention processes-research, theory and implications for special education: A Review. In B. K. Keogh, (Ed.). Advances in special education, (Vol. 1, pp. 101-140). Greenwich, Connecticut: Jai Press.

Lashley, K. S. (1951). The problem of serial order in behavior. In L. A. Jeffreys (Ed.), Cerebral mechanisms in behavior: The Hixon symposium. New York: Wiley.

Lefton, L. A., Lahey, B. B. & Stagg, D. I. (1978). Eye movements in reading disabled and normal children: A study of systems and strategies. Journal of Learning Disabilities, 11, 549-558.

Lenneberg, E. (1967). Biological foundations of language. New York: Wiley.

Leong, C. K. (1976). Lateralization in severely disabled readers in relation to functional cerebral development and synthesis of information. In R. M. Knights & D. J. Bakker (Eds.), The neuropsychology of learning disorders: Theoretical approaches. Baltimore: University Park Press.

Leong, C. K. (1974). Spatial-temporal information processing in disabled readers. Unpublished doctoral dissertation, University of Alberta, Edmonton.

Lerner, J. (1983). Learning disabilities: Theories, diagnosis and teaching strategies. Boston: Houghton Mifflin Company.

Levin, H. & Kaplan, G. J. (1970). Grammatical structures and reading. In Levin, H. & Williams, J. (Eds.). Basic studies on reading. New York: Basic Books.

Liberman, I. Y. & Schankweiler, D. (1979). Speech, the alphabet, and teaching to read. In L. Resnick and P. Weaver (Eds.), Theory and practice of early reading. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Liberman, I. Y., Shankweiler, D., Liberman, A. M., Fowler, C. & Fischer, F. W. (1977). Phonemic segmentation and recording in the beginning reader. In A. S. Reber & D. Scarsborough (Eds.), Towards a psychology of reading. Hillsdale, NJ: Erlbaum.

Liberman, I. Y., Schankweiler, D., Orlando, C., Harris, K. S. & Berti, F. B. (1971). Letter confusion and reversals of sequence in the beginning reader: Implications for Orton's theory of developmental dyslexia. Cortex, 7, 127-142.

Lippman, M. Z. (1971). Correlates of contrast word associations:developmental trends. Journal of Verbal Learning and Verbal Behavior, 10, 392-399.

Lochhart, R. S., Craik, F. I. M. & Jacoby, L. L. (1976). Depth of processing, recognition and recall. In J. Brown, (Ed.), Recognition and recall. New York: John Wiley & Sons.

Lowenthal, F., Vandamme, F. & Cordier, J. (1982). Language and language acquistion. New York: Plenum Press.

Luria, A. R. (1961). The role of speech in the regulation of normal behavior. Oxford: Pergamon Press.

Luria, A. R. (1966). Human brain and psychological processes. New York: Harper and Row.

Luria, A. R. (1966). Higher cortical functions in man. New York: Basic.

Luria, A. R. (1970). Traumatic aphasia: Its syndromes, psychology and treatment. The Hague: Mouton.

Luria, A. R. (1973). Two basic kinds of aphasiac disorders. Lingua, 115, 57-66.

Luria, A. R. (1973). The working brain. London: Penguin.

Luria, A. R. (1976). Basic problems of neurolinguistics. The Hague: Mouton.

Luria, A. R. (1980). Neuropsychology in the local diagnosis of brain damage. Clinical Neuropsychology, 2, 1-7.

Luria, A. R. (1982). Language and cognition. New York: John Wiley.

Lyle, J. G. (1968). Performance of retarded readers on the memory-for-designs test. Perceptual and Motor Skills, 26, 851-854.

Lyon, R. (1982). Subgroups of learning disabled readers: Clinical and empirical identification. In H. R. Myklebust (Ed.), Progress in learning disabilities (Vol. 5). New York: Grune and Stratton.

Lyon, R. & Watson, B. (1981). Empirically derived subgroups of learning disabled readers: Diagnostic considerations. Journal of Learning Disabilities, 14, 256-261.

MacMillan, D. L., Meyers, C. E. & Morrison, G. M. (1980). System-identification of mildly retarded children: Implications for conducting and interpreting research. American Journal of Mental Deficiency, 85, 108-115.

Malatesha, R. N. & Whitahen, H. A. (Eds.). (1984). Dyslexia: A global issue. The Hague: Martinus Nijhoff Publisher.

Masland, R. (1979). Subgroups in dyslexia: Issues in definition. Bulletin of the Orton Society, 29, 23-30.

Mattingly, I. G. (1972). Reading, the linguistic process, and linguistic awareness. In J. T. Kavanagh and I. G. Mattingly (Eds.), Language by ear and by eye. Cambridge: MIT Press.

Mattis, S., French, J. H. & Rapin, I. (1975). Dyslexia in children and young adults: Three independent neuropsychological syndromes. Developmental Medicine and Child Neurology, 17, 150-163.

Mc Guigan, F. J. (1967). Feedback of speech muscle activity during silent reading: Two comments, Science, 157, 579-580.

McIntyre, C. W., Murray, M. E., Cronin, C. M. & Blackwell, S. L. (1978). Span of apprehension in learning disabled boys. Journal of Learning Disabilities, 11, 468-475.

McNeill, D. (1963). The origin of associations within the same grammatical class. Journal of Verbal Learning and Verbal Behavior, 2, 250-262.

McNeill, D. (1966). A study of word associations. Journal of Verbal Learning and Verbal Behavior, 5, 548-557.

McNeill, D. (1970). The acquisition of language: The study of developmental psycholinguistics . New York: Harper & Row.

McNinch, G. (1972). Paradigmatic language training as a method of increasing reading achievement. Twenty-first Yearbook of National Reading Conferences. 100-109. Tempa, Florida.

Meichenbaum, D. (1976). Cognitive factors as determinants of learning disabilities: A cognitive - functional approach. In R. M. Knights & D. J. Bakker, (Eds.), The neuropsychology of learning disorders: Theoretical approaches. Baltimore: University Park Press.

Meier, J. (1971). Prevalence and characteristics of learning disabilities found in second-grade children. Journal of Learning Disabilities, 4, 6-21.

Menyuk, P. & Flood, J. (1981). Linguistic competence, reading, writing problems and remediation. Bulletin of the Orton Society, 31, 13-28.

Montgomery, D. (1981). Do dyslexics have difficulty accessing articulatory information? Psychological Research, 43, 235-243.

Moran, L. J. (1966). Generality of word association response sets. Psychological Monographs, 80, (4, whole, #612).

Morrison, F. J., Giordani, B. & Nacy, J. (1977). Reading disability: An information-processing analysis. Science, 196, 77-79.

Moynahan, E. D. (1978). Assessment and selection of paired associate strategies: A developmental study. Journal of Experimental Child Psychology, 26, 257-266.

Mulcahy, R. (1980). Memory: some selective aspects. In R. F. Jarman & J. P. Das, (Eds.), Issues in Developmental Disabilities. Ann Arbor, Michigan: University Microfilms International.

Myklebust, H. & Boshes, B. (1969). Minimal brain damage in children (Final Report, U.S. Public Health Service Contact 108).

Myklebust, H. R. (1973). Development and disorders of written language: studies of normal and exceptional children. NY: Grune & Stratton.

Myklebust, H. R. (Ed.). (1978). Progress in learning disabilities. New York: Grune and Stratton.

National Advisory Committee on Handicapped Children. (1968). Subcommittee in education of the committee on labor and public welfare. (First Annual Report). Washington, DC: U.S. Government Printing Office.

Naus, M. J., Ornstein, P. A. & Hoving, K. L. (1978). Developmental implications of multistore and depth of processing models of memory. In P. A. Ornstein (Ed.), Memory development in children, (pp. 219-231). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Neisser, U. (1967). Cognitive psychology. New York: Appleton-Century-Crofts.

Neisworth, J. T. & Greer, J. G. (1975). Functional similarities of learning disability and mental retardation. Exceptional Children, 42, 17-21.

Nelson, K. (1974a). Concept, word and sentence: Interrrelationships in acquisition and development. Psychological Review, 81, 267-285.

Nelson, K. (1974a). Variations in children's concepts by age and category. Child Development, 45, 577-584.

Nelson, K. (1976). Some attributes of adjectives used by young children. Cognition, 4, 13-30.

Nelson, K. (1977). The syntagmatic-paradigmatic shift revisited: A review of research and theory. Psychological Bulletin, 84, 93-116.

Nelson, K. (1979). Explanations in the development of a functional semantic memory. In. K. A. Collins (Ed.), Children's language and communication – the Minnesota symposium on child psychology. (Vol. 12). Hillsdale, NJ: Erlbaum.

Nikkel, N. & Palermo, D. S. (1965). Effects of mediated associations in paired-associate learning of children. Journal of Experimental Child Psychology, 2, 92-101.

Ogston, D. G. (1973). The technical standards of intellective tests used in Alberta elementary schools: A review. The Alberta Jornal of Educational Research, 19, 270-283.

Olson, David R., Goldstein, F. & Levin, H. S. (1985). Intellectual & academic outcome following closed head injury in children & adolescents: research strategies & empirical finding. Developmental Neuropsychology, 1, 195-214.

Ornstein, P. A. (1978). Introduction: The study of children's memory. In P. A. Ornstein, (Ed.), Memory development in children (pp. 1-20). Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Orton, S. T. (1937). Reading, writing and speech problems in children. New York: Norton.

Otto, C. G. (1976). Paradigmatic-syntagmatic word association and its relationship to grade one achievement. Unpublished master's thesis, University of Alberta, Edmonton.

Paivio, A. & Yuille, J. C. (1966). Word abstractness and meaningfulness, and paired-associate learning in children. Journal of Experimental Child Psychology, 4, 81-89.

Palermo, D. S. (1971). Characteristics of word association responses obtained from children in grade one through four. Developmental Psychology, 5, 118-123.

Palermo, D. S. & Jenkins, J. J. (1964). Word association norms: Grade school through college. Minneapolis: University of Minnesota Press.

Paris, S. G. & Lindauer, B. K. (1977). Constructive aspects of children's comprehension and memory. In R. V. Kail and J. W. Hagen (Eds.), Perspectives on the development of memory and cognition. Hillsdale, New Jersey: Lawrence Erlbaum Associates.

Parker, T. B., Frenton, C. W. & Drew, C. J. (1975). Comparison of verbal performance of normal and learning disabled children as a function of input organization. Journal of Learning Disabilities, 8, 386-392.

Patel, P. G. (1977). The left-parieto-temporo-occipital junction, semantic aphasia and language development around age seven. Linguistics, 196, 35-48.

Penk, W. E. (1971). Developmental changes in idiodynamic sets of children's word associations. Developmental Psychology, 5, 55-63.

Perfetti, C. A. (1984). Reading acquisition and beyond-decoding includes cognition. American Journal of Education, 93: 40-60.

Piaget, J. & Inhelder, B. (1969). The psychology of the child. New York: Basic Books.

Postman, L. & Keppel, G. (1970). Norms of word association. New York: Academic Press.

Pribam, K. H. (1971). Language of the brain: Experimental paradoxes and principles in neuropsychology. Englewood Cliffs, N.J.: Prentice-Hall.

Preston, M., Guthrie, J. T. & Childs, B. (1974). Visual evoked response in normal and disabled readers. Psychophysiology, 11, 452-459.

Reid, J. F. (1973). Towards a theory of literacy. In M. Clark, & A. Milne (Eds.), Reading and related skills. London: Ward Loch.

Reynolds, C. R. (1984). Critical measurement issues in learning disabilities. The Journal of Special Education, 18, 451-474.

Reynolds, C. R. (1985). Measuring the aptitude-achievement discrepancy in learning disability diagnosis. Remedial and Special Education, 6, 37-48.

Riley, L. & Fite, G. (1974). Syntagmatic versus paradigmatic paired-associate acquisition. Journal of Experimental Psychology, 103, 375-376.

Rosanoff, I. R. & Rosanoff, S. J. (1913). A study of association in children. Psychological Review, 20, 43-89.

Rosenthal, J. H. (1970). A preliminary psycholinguistic study of children with learning disabilities. Journal of Learning Disabilities, 3, 11-15.

Ross, A. O. (1976). Psychological aspects of learning disabilities and reading disorders. New York: McGraw Hill.

Ross, D. (1971). Retention and transfer of mediation set of paired-associate learning of educable retarded children. Journal of Educational Psychology, 62, 322-327.

Rourke, B. P. (1975). Brain-behavior relationships in children with learning disabilities. American Psychology, 30, 911-920.

Rourke, B. P. (Ed.). (1985). Neuropsychology of learning disabilities. New York: Guilford Press.

Ryckman, D. B. (1981). Reading achievement, IQ and simultaneous-successive processing among normal and learning disabled children. Alberta Journal of Educational Research, 27, 74-83.

Salvia, J. & Clark, J. (1973). Use of deficits to identify the learning disabled. *Exceptional Children*, *39*, 305-308.

Satz, P. & Morris, R. (1981). Learning disabilities subtypes: A review. In F. S. Pirozzolo and M. A. Wittrock (Eds.), *Neuropsychological and cognitive processes in reading*. New York: Academic Press.

Satz, P., Morris, R. & Fletcher, J. M. (1985). Hypotheses, subtypes and individual differences in dyslexia: some reflections. In D. Gray, & J. Kavanagh (Eds.), *Biobehavioral measures of dyslexia*. Parkton, MD: York Press.

Schank, R. (1976). The role of memory in language processing. In C. Cofer & R. Atkinson (Eds.), *The structure of human memory*. San Francisco: Freeman.

Shankweiler, D., Liberman, I. Y., Mark, L. S., Fowler, C. A. & Fischer, F. W. (1979). The speech code and learning to read. *Journal of Experimental Psychology*, *5*, 531-545.

Shapiro, S. I. & Palermo, D. S. (1968). Mediation in children's aural paired-associate learning. *Child Development*, *39*, 569-577.

Shen, S. & McNinch, G. The relationship between language associations and reading achievement in the eighth grade. *Southern Journal Educational Research*, *5*, 40-50.

Smith, C. R. (1983). *Learning disabilities: The interaction of learner, task and setting*. Toronto: Little, Brown & Company.

Snart, F. D. (1979). *Levels of processing and memory: A developmental approach*. Unpublished doctoral dissertation, University of Alberta, Edmonton.

Snowling, M. (1981). Phonemic deficits in developmental dyslexia. *Psychological Research*, *43*, 219-234.

Snyder, L. (1980). Have we prepared the language disordered child for school? In K. Butler and G. Wallach (Eds.), *Topics in language disorders*, (Vol. 1), pp. 29-46.

Spring, C. (1976). Encoding speed and memory span in dyslexic children. *The Journal of Special Education*, *10*, 35-40.

Spring, C. & Capps, C. (1974). Encoding speed, rehearsal and probed recall of dyslexic boys. *Journal of Educational Psychology*, *66*, 780-786.

Stanovich, K. (1985). Explaining the variance in reading ability in terms of psychological processes & whatever we learned? *Annals of Dyslexia*, *35*, 67-96.

Stark, J. (1981). Reading: what needs to be assessed? Topics in Language Disorders, 1, 87-94.

Steinberg, E. R. & Anderson, R. C. (1975). Hierarchical semantic organization in six-year-olds. Journal of Child Psychology, 19, 544-553.

Sternberg, R. J. (1979). The nature of mental abilities. American Psychology, 14, 214-230.

Sternberg, R. J. (Ed.). (1985). Human abilities: An information-processing approach. New York: W. H. Freeman and Company.

Stevenson, H. W. (1972). Children's learning. New York: Meredith Corporation.

Stolz, W. S. & Tiffany, J. (1972). Production of child-like word associations by adults to unfamiliar adjectives. Journal of Verbal Learning and Verbal Behavior, 11, 38-42.

Strauss, A. & Lehtinen, L. (1947). Psychopathology and education of the brain-injured child. New York: Grune and Stratton.

Strominger, A. Z. & Bashir, A. S. (1977). A nine-year follow-up of language-delayed children. Presented at the Annual Convention of the American Speech-Language and Hearing Association, Chicago.

Swanson, H. L. (1979). Auditory recall of conceptually, phonetically, and linguisitically similar words by normal and learning disabled children. Journal of Special Education, 13, 63-67.

Swanson, H. L. (1980). Auditory and visual vigilance in normal and learning disabled readers. Learning Disability Quarterly, 3, 71-78.

Swanson, H. L. (1982). In the beginning was a strategy: Or was it a constraint? Topics in Learning and Learning Disabilities, 2, x-xiii.

Swanson, H. L. (1987). Information processing theory and learning disabilities: a commentary and future perspective. Journal of Learning Disabilities, 20, 153-166.

Tabachnick, B. G. & Fidell, L. S. (1983). Using multivariate statistics. New York: Harper & Row.

Tallal, P. (1980). Auditory temporal perception, phonics, and reading disabilities in children. Brain and Language, 9, 182-198.

Tallal, P. & Stark, M. E. (1980). Speech perception of language - delayed children. In J. Heron (Ed.), Neuropsychology of left-handedness, 155-171. New York: Academic Press.

Tallal, P., Stark, M. E. & Mellits, E. D. (1981). Language disabilities in children: Perceptual correlates. International Journal of Pediatric Otorhinolaryngology, 3, 1-13.

Torgeson, J. K. (1975). Problems and prospects in the study of learning problems. Chicago: University of Chicago Press.

Torgeson, J. K. (1979). Factors related to poor performance on memory tasks in reading disabled children. Learning Disability Quarterly, 2, 17-23.

Torgeson, J. K. & Houck, D. G. (1980). Processing deficiencies of learning-disabled children who perform poorly on the digit span test. Journal of Educational Psychology, 72, 141-160.

Towner, B. D., Trupin, E. W., Martin, D. C., & Goldstein, D. (1980). Neuropsychological correlates of academic success among elementary school children. Journal of Consulting and Clinical Psychology, 48, 675-684.

Tulving, E. (1985). How many memory systems are there? American Psychologist, 40, 385-398.

U. S. General Accounting Office. (1981). Disparities still exist in who gets special education. Washington, DC: Comptroller General of the United States.

U. S. Office of Education. (1977). Education of handicapped children. Implementation of Part B of the Education for Handicapped Act, Federal Register, Part II. Washington, D.C.: U. S. Department of Health, Education and Welfare.

U. S. Department of Education. (1984). To assure the free appropriate public education of all handicapped children. Sixth Annual Report to Congress on the Implementation of PL 94-142, The Education of All Handicapped Children Act. Washington, D.C.: U. S. Department of Education.

Vellutino, F. R. (1978). Toward and understanding of dyslexia: Psychological factors in specific reading dyslexia. In P. Benton & D. Pearl (Eds.), Dyslexia: An appraisal of current knowledge, (pp. 63-111). New York: Oxford University Press.

Vellutino, F. R. (1979). The validity of perceptual deficit explanations of reading disability: A reply to Fletcher and Satz. Journal of Learning Disabilities, 12, 160-167.

Vellutino, F. R., Steger, B. M., Moyer, S. C., Harding, C. J. & Niles, J. A. (1977). Has the perceptual deficit hypothesis led us astray? Journal of Learning Disabilities, 10, 375-385.

Vernon, P. E. *et al.* (1978). Simultaneous and successive processing an attempt at replication. Canadian Journal of Behavioral Science, 10, 1-15.

Vogel, S. A. (1975). Syntactic abilities in normal and dyslexic children. Baltimore: University Park Press.

Vygotsky, L. S. (1962). Thought and language. Cambridge, Mass.: MIT Press.

Vygotsky, L. S. (1978). Mind in society: the development of higher psychological processes. Cambridge Harvard University Press.

Wachs, T. D. & Gruen, G. E. (1971). The effects of chronological age, trials and list characteristics upon children's category clustering. Child Development, 42, 1217-1227.

Wallach, G. P. & Butler, K. G. (Eds.). (1984). Language learning disabilities in school-age children. Baltimore: Williams and Wilkins.

Weigl, E. & Bierwisch, M. (1970). Neuropsychology and linquistics: Topics of common research. Foundations of Language, 6, 1-18.

Weener, P. (1981). On comparing learning disabled and regular classroom children. Journal of Learning Disabilities, 14, 227-232.

Wepman, J. M. (1960). Auditory discrimination, speech and reading. Elementary School Journal, 60, 325-333.

Wepman, J. M. (1970). Auditory discrimination, speech and reading. The Elementary School Journal, 9, 325-333.

White, S. (1965). Evidence for a hierarchical arrangement of learning processes. In L. P. Lipsett & C. C. Spider (Eds.), Advances in child development and behavior, (Vol. 3). New York: Academic Press.

Wiig, E. H. & Semel, E. M. (1975). Logico-grammatic sentence comprehension by adolescents with learning disabilities. Perceptual and Motor Skills, 38, 1331-1334.

Wiig, E. H. & Semel, E. M. (1976). Language disabilities in children and adolescents. Columbus, Ohio: Charles E. Merrill Publishing Company.

Wiig, E. H. & Semel, E. M. (1980). Language assessment and intervention for the learning disabled. Columbus, Ohio: Charles E. Merrill Publishing Company.

Wiig, E. H., Semel, E. & Nystrom, L. (1982). Comparison of rapid naming abilities in language-learning-disabled and academically achieving eight-year-olds. Language and Speech and Hearing Services in Schools, 13, 11-22.

Witelson, S. (1977). Developmental dyslexia: two right hemispheres and none left. Science, 19, 309-311.

Wittrock, M. C. (1986). Students' thought processes. In M. C. Wittrock, (Ed.), Handbook on research on teaching, (3rd ed.), pp. 297-314. NY: MacMillan Publishing Co.

Wood, M. L. (1982). Language disorders in school-age children. Englewood Cliffs: Prentice Hall, Inc.

Woodrow, H. & Lowell, F. (1916). Children's association frequency tables. Psychological Monographs, 22, (whole # 97).

Woodworth, R. S. & Schlosberg, H. (1954). Experimental psychology (rev. ed.). New York: Holt, Rinehart and Winston.

Ysseldyke, J. E. (1982). Bias among professionals who erroneously declare students eligible for special services. Journal of Experimental Education, 50, 223-228.

Ysseldyke, J. E., Algozzine, B. & Epps, S. (1983). A logical and empirical analysis of current practice in classifying students as handicapped. Exceptional Children, 50, 160-156.

Ysseldyke, J. E. & Thurlow, M. L. (1984). Assessment practices in special education: Adequacy and appropriateness. Educational Psychologist, 19, 123-136.

Ysseldyke, J., Shirn, M., Deno, S. & Tindal, C. (1986). A comparison of differences between students labelled learning disabled & low achieving on measures of classroom performance. Journal of Learning Disabilities, 19, 545-552.

APPENDIX A

LANGUAGE PROCESSING TASKS

FREE WORD ASSOCIATION TASK

LIST ONE (PARADIGMATIC)

table-
river
move-
usually-
yellow-
chair-
allow-
he-
bright-
loudly-

LIST TWO (SYNTAGMATIC)

colour-
give-
enjoy-
ocean-
clean-
never-
they-
slowly-
pretty-
carry-

CLOSED ASSOCIATION TASK

LIST ONE (PARADIGMATIC)

hot - warm/fire

high - up/sky

dark - black/night

tell - secret/talk

him - he/her

run - fast/walk

harder - softer/stone

desk - write/table

back - behind/front

sheep - woolly/animal

LIST TWO (SYNTAGMATIC)

wicked - witch/bad

cheat - lie/bad

grass - trees/green

music - sing/song

float - light/sink

night - dark/day

eating - supper/drinking

worked - played/hard

soft - pillow/hard

bee - sting/insect

PAIRED ASSOCIATION TASK

LIST ONE (SYNTAGMATIC)

add - numbers

clean - house

cold - water

dark - night

hard - work

long - hair

run - fast

sit - down

square - box

black - ball

LIST TWO (PARADIGMATIC)

flower - blossom

sweet - sour

milk - cheese

gently - softly

high - tall

skip - hop

needle - pin

sheep - lamb

take - carry

quickly - swiftly

MEDIATED FREE WORD ASSOCIATION TASK

LIST ONE (PARADIGMATIC)

hand-
sit-
fruit-
sell-
loud-
belong-
tall-
then-
sometimes-
man-

LIST TWO (SYNTAGMATIC)

bird-
square-
listen-
always-
sad-
gently-
begin-
she-
pleasant-
salt-

APPENDIX B

SCORING CRITERIA FOR SYNTAGMATIC AND PARADIGMATIC RESPONSES

SCORING CRITERIA FOR SYNTAGMATIC AND PARADIGMATIC RESPONSES

NOTE: Responses must be one word. They may be preceded by 'a' or 'the.' Responses must be real English words.

PARADIGMATIC RESPONSES:

Responses are classified as paradigmatic if:

1. They are of the same form class as the stimulus word (i.e., noun, verb, adjective, adverb). Pronouns may be classified with nouns (for example, he/boy would be paradigmatic).

and

2. They fall within one of the categories of:

   co-ordinate (same category; e.g., car/truck; small/tiny)
   (synonyms would fall in this category)

   superordinate (e.g., apple/fruit; table/furniture)

   contrast (e.g., bright/dark; loudly/quietly)

   part-whole (e.g., hand/fingers; tree/branch)

If the stimulus word can be substituted for the response word in a simple sentence, and it is grammatically correct, it is probably paradigmatic. For example, the stimulus word sun and response word moon may be substituted for one another in a simple sentence: I saw the sun; I saw the moon.

Conversely, the stimulus word sun and response word bright may not be substituted for one another: I saw the sun; I saw the bright. This response (sun/bright) would be scored as syntagmatic.

SYNTAGMATIC RESPONSES:

Responses are scored as syntagmatic if:

They grammatically can preced or follow the stimulus word in a sentence.

They are derived from the stimulus word (i.e. root word), as in happy/unhappy.

They are a function or property of the stimulus word (for example, horse/run; sheep/wool).

Words that go together to form a whole word, such as flowerpot (stimulus flower, response pot) and tablecloth (stimulus table, response cloth) would be scored as syntagmatic.

CLANG RESPONSES:

These are rhyming words that may or may not be real words, as in in/pin; tall/mall; square/mall. They are scored as zero, except when they are conceptually correct (e.g., light/bright).

APPENDIX C

TASK INSTRUCTIONS

GENERAL INSTRUCTIONS TO TESTERS

On entering the school, you should have your list of student ID numbers, enough forms of each task for each child, two pens, and stickers. Go to the office first, identify yourself, and tell them that you are participating in the testing with the students on your list. Ask for the names to match the ID numbers, as well as the room numbers of the children. In most cases, the school will have the original ID list, with student names beside it.

Ask for all the permission slips as well, and put a check beside those students who have brought them back. ONLY TEST THOSE WHO HAVE RETURNED PERMISSION SLIPS.

You are going to be administering several types of language tasks to the children assigned to you. Please make the children feel comfortable, then read the instructions provided for each task. You will be required to write down the children's responses to each item on each task.

None of the tasks are timed. However, should a child not respond to an item within about ten seconds, re-administer the item. Encourage the children to respond quickly, i.e., with the first word which comes to mind. If a child does not respond to an item after two administrations, write "NR" for "no response", and proceed to another item. You may administer that item later within the same task.

NOTE: On all tasks, except tasks five and six,it is important to administer the items in random order, irregardless of the task number. On tasks five and six, the items within each list must be presented in random order, and the lists should be presented alternately, but the two word lists should not be combined.

It would be helpful if you could record any unusual behavioral responses to any of the tasks on the response form itself.

When the testing session is complete, please thank the child for their participation, allow them to choose a sticker, and walk with them back to their classroom to get the next child.

GENERAL INSTRUCTIONS, AND INSTRUCTIONS FOR TASKS ONE AND TWO (FREE WORD ASSOCIATION)

After introducing yourself, and asking the child his/her name, say to the child:

"Thank you for coming to help me today. We are going to play some word games. There are no right or wrong answers in these word games. We will play them for about fifteen or twenty minutes. I will write down your answers."

"In this first game, I will say a word, and I want you to say the first word that you think of when you hear my word. Do you undertant? I will say a word, and you say the first word that you think of. OK? Good."

"Now, what is the first word you think of when I say tree?"

When the child responds, say, "That's it! Just tell me the first word you think of when I say my word.")

(If the child does not respond, say, "What word do you think of when I say car?")

Continue with the word on the word list, gradually phasing out the "What word do you think of..." instruction, and just saying the stimulus word itself. As instructed, administer the items in both lists in random order (i.e., randomize both lists simultaneously), until all words have been administered. Record each response as given.

INSTRUCTIONS FOR TASKS THREE AND FOUR (CLOSED ASSOCIATION)

Say to the student: "In this game, I will say a word, and then two more words. I want you to tell me which word goes best with the first word. Do you understand? I'll say a word, and then ask you to pick which other word goes best with that word. Let's try it."

For each word trio on the list, say, "Does (stimulus word) go better with (response word) or (response word) Record each response as given. Administer the items in both lists in random order (i.e., randomize both lists simultaneously), until all items have been administered.

INSTRUCTIONS FOR TASK FIVE AND SIX (PAIRED ASSOCIATE)

Present the word pairs in random order, one list at a time. Alternate the order of the lists (i.e., task five and six) with each student. In other words, administer task five first to student A, then task six first to student B, and so on. Administer each task in its entirety before proceeding to the next task.

Say to the student: "In this game, I am going to read you a list of word pairs. I would like you to listen carefully and try to remember the words that go together in pairs. When I am finished, I will tell you one of the words in each pair, and I would like you to tell me the other word from the pair. Do you understand? Listen carefully and remember the words that I say together."

*EXAMINERS: Read each pair of words, one word per second, then pause for two seconds, so the children will hear the two words as a pair, separated from the next pair. Read the word pairs in random order. Continue this format for the first list, remembering to alternate the order of the tasks with each student. Then say,

"Now I will say one of the words in the word pair, and I want You to tell me what you think the other word in the pair was. Are you ready? What word went with (stimulus word)?"

Record each response, continuing through the task in random order. *
Then say,

"Good. Now I am going to read another list of word pairs, I would like you to listen carefully again, and try to remember these words that go together in pairs. When I am finished, I will tell you one of the words in each pair, and I would like you to tell me the other word for the pair. Listen carefully and remember the words that I say together."

Continue administration as directed above, from * to *, pausing between each word pair. Then say,

"Now, I will read each list of words again. Then, I will say one of the words in the word pair again, and I'd like you to tell be the word that goes with it."

Repeat the entire procedure until all items in both tasks have been administered twice.

5

INSTRUCTIONS FOR TASK SEVEN AND EIGHT

(MEDIATED FREE WORD ASSOCIATION)

Say:
"We're going to play another word game. In this word game, we are going to think of some "thing" words, some "doing words, some "what kind" words and some "how" words. I will explain what each of these kinds of words means."

"Some words are thing words. For example, tree is a thing word. When I say a thing word, I want you to tell me another thing word that you can think of when you hear my thing word. So, if I day tree what word do you thing of? Tree......." (Pause for response). If correct, say "Right! (_________) is a thing word. Now, if I say horse, what word do you think of? Horse...." (Pause for response.) If correct, say "Good".

If either answer is incorrect, go over the instructions again. You may substitute the words lamp, paper or car, if needed, but do not use any other words for examples, as they might be or have been a test word.

Say:
"Those were thing words. Some other words are doing words. Walk is a doing word. When I say a doing word like walk, I want you to think of another doing word. Walk....." (Pause for response.) If correct, say, "That's right. (_________) is a doing word. Now, if I say a doing word like ride, what doing word can you think of? Ride......." (Pause for response). If correct, say, "Good".

If answer is not correct, repeat the instructions, substituting jump or draw.

Say, "We've talked about thing words and doing words. Other words are what kind words. They tell about something. For instance, small is a what kind word. If I tell you a what kind word like small, what what kind word do you think of? Small..." (Pause for response). If correct, say, "That's right. (_________) is a what kind word. Now, if I say a what kind word like ride, what doing word can you think of? Ride......." (Pause for response). If correct, say, "Good".

If answer is not correct, repeat the instructions, substituting happy or big.

Say, "We've talked about thing words, doing words and what kind words. Other words are how words. How words tell how somehing is done. For instance, quickly is a how word. What how word do you think of when I say quickly? Quickly..... (Pause for response). If correct, say, "That's right. (_________) is a how word. Now, if I say a how word like ride, what how word can you think of? Ride......."
(Pause for response).

If correct, say, "Good".

If answer is not correct, repeat the instructions, substituting fast or noisily.

Say, "We have talked about thing words, doing words, what kind words and how words. When I tell you a word, I would like you to think of the same kind of word I am saying. So, if I tell you a thing word, I want you to think of a thing word too. If I say a doing word, I want you to say a doing word. If I say a what king word, I want you to say a what kind word too. And, if I say a how word, I would like you to say a how word too. Do you understand?"

Begin reading aloud the words from the two word lists, in random order, pausing for each response. DO NOT INDICATE WHETHER THE RESPONSE IS INCORRECT OR CORRECT, JUST RECORD IT AND GO ON TO ANOTHER WORD.

Continue tasks until all words have been administered.

"Now, I will say one of the words in the word pair, and I want you to tell me what you think the other word in the pair was. Are you ready? What word went with (stimulus word)? Record response. Continue through the list, in random order, until all items have been administered.

Repeat procedure with the second list.